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Optimized Fuel Tank Sender Closure		

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1. Scope

This practice describes recommended performance requirements of fuel tank closures used in conjunction with fuel level senders and fuel delivery systems. It provides guidelines that assure interchangeability and compatibility between fuel tanks and fuel pump/sender closure systems without specifying a specific closure system design. These systems may be used in rigid fuel tank systems made of plastic or metal.

Complete details of specific designs shall be established by mutual agreement between customer and supplier.

The dimensions and performance requirements are selected to optimize

- a. The closure system, durability and reliability with respect to
 - Vehicle SHED measurements
 - Fuel system / crash integrity
 - LEV – II useful life
- b. Assembly and service ease and reliability
- c. Packaging of fuel tanks and their sending units
- d. Interchangeability of sender closures between various fuel tank designs

1.1 Rationale

Not applicable.

2. References

2.1 Applicable Publications

The following publication forms a part of the specification to the extent specified herein. Unless otherwise indicated, the latest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1681—Gasoline, Alcohol, and Diesel Fuel Surrogates for Material Testing

SAE J1737—Test Procedure to Determine the Hydrocarbon Losses from Fuel Tubes, Hoses, Fittings, and Fuel Lines Assemblies by Recirculation

SAE J1645—Fuel System—Electrostatic Charge

SAE J2027—Standard for Protective Covers for Gasoline Fuel Line Tubing

2.1.2 ASTM PUBLICATION

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117-03—Standard Practice for Operating Salt Spray (Fog) Apparatus

3. *Recommended Dimensions and Features*

3.1 The recommended Fuel tank nominal Opening IDs are listed below. Related dimensions are listed in Appendix A.

3.1.1 Fuel Tank Nominal Opening I.D.

3.1.2 130.5 mm (Standard opening to be used in all cases whenever possible).

3.1.3 95.5 mm (For exceptions not requiring a large opening i.e., dual chamber tanks, Sub-side or sender only applications).

3.1.4 115.5 mm (For exceptions such as fuel tanks having flat space insufficient to accommodate a 130 mm opening, etc.).

3.1.5 The significant dimensions for the interchangeable parts of each nominal design size is defined as shown in Figures 1, 2 and 3 and listed in Appendix A, Table 1.

3.1.6 Exact dimensions, tolerances, and critical dimensions need to be established for the specific designs and materials utilized for compliance to this recommended practice. Complete dimensional analysis of a specific design is required to ensure that under all conditions a properly performing connection is made and that all stresses created by the connection are consistent with material performance requirements.

3.2 **Mechanical Retention**

As required to meet mechanical strength and durability requirements.

3.2.1 Retainer must be capable of being unlocked, removed and reinstalled in service using only ordinary tools. The use of special tools is a better practice when available.

3.2.2 Effort to manually install the mechanical retention system should not exceed applicable ergonomic criteria. (The installation effort for Cam-lock systems should not exceed 250 Nm when new or 350 Nm in service.

3.2.3 Removal force to unlock and open the mechanical retention system should not exceed 400 Nm.

3.2.4 Variations in the coefficient of friction between rotational locking mechanisms and interface closures (module flanges) will result as a function of materials and/or coatings chosen for interface subcomponents. These variations may result in initial and in-service torque results above those stated in 3.2.2. Therefore, it is up to the fuel system supplier and customer to resolve an amicable torque threshold for each module interface and its unique material/coating combinations.

3.3 Sender Orientation Feature

Sender cover should be equipped with a feature that:

- 3.3.1 Precludes installation of the sender into the fuel tank opening in any but the intended position and orientation.
- 3.3.2 Does not adversely affect the overall size of the closure system.
- 3.3.3 Does not interfere with the function of the gasket or the mechanical retention means.
- 3.3.4 Does not act as a stress concentrator that weakens the joint to bending, compressive, tensile or torsional forces.
- 3.3.5 Is not incorporated in the seal groove or ID module hole.

3.4 Gasket and Its Gland

- 3.4.1 Gasket should be sufficiently rigid or otherwise supported by mating components such that it cannot be dislodged from its operating position during the usual assembly of mating components.
- 3.4.2 The gasket and mating components should be designed so that the gasket cannot be dislodged from its operating position in a reasonably severe vehicle crash by minimizing the permanent or gross momentary distortion of, or damage to, the gasket joint.
- 3.4.3 System design stack up tolerances must comply within the seal manufacturer's recommended compression range of the material utilized and geometry. Example: Seals made of FKM 70% fluorine, with durometer points Type A 65 ± 5 , Compression set 30% Max after 70 hours at 150 °C. These properties may not apply to other gasket material.
- 3.4.4 The joint should be designed to meet the performance requirements in this document at the extremes of the tolerance stack-up.
- 3.4.5 Gasket or gland should be designed so that gasket volume does not exceed gland volume at the maximum material tolerance condition. Volume changes caused by fuel absorption should be included in this tolerance stack up.
- 3.4.6 Gasket should not consist of a traditional "flat" design unless the mating components are stiff enough to be considered rigid when compared to the gasket stiffness throughout the expected tolerance stack-up. (Flat gasket designs with limited compression range compressed between flexible flat tank and cover surfaces are not recommended).
- 3.4.7 The gasket material(s) should be selected only after considering the following properties at a minimum.
 - 3.4.7.1 Resistance to fuels and external chemicals.
 - 3.4.7.2 Volumetric swell in fuels.

- 3.4.7.3 Compression set and compression stress relaxation.
- 3.4.7.4 Mechanical and physical properties after exposure to fuels.
- 3.4.7.5 Mechanical properties after exposure to fuels and dry out.
- 3.4.7.6 Sealing properties at low temperature.
- 3.4.7.7 Properties after long term exposure to the maximum expected temperature.
- 3.4.7.8 Permeation resistance.
- 3.4.8 Gasket should be replaced whenever the fuel tank closure is disassembled.
- 3.4.9 Refer to Appendix A, Table 1, and Figures 1, 2 and 3 for standard dimensions and features for fuel tank sender closure systems. Alternative designs must be completely compatible with Figure 1 and its dimensions. Tolerances need be defined for specific application.
- 3.4.10 Appendix B shows fuel tank closure system with different gasket shapes and gland conditions that may affect the performance of the closure system.

4. Functional Requirements

The following are the requirements used to judge the suitability of a design. These are used in conjunction with various impact events and durability cycles described in the next sections to assure that the functions can be met before and after life cycle exposures to various stresses.

The recommended minimum sample size for each test is three.

4.1 Leak Tightness

4.1.1 REQUIRED TEST EQUIPMENT

- 4.1.1.1 Test fixtures and equipment should be suitable for efficient leak testing of the intended parts or modules. It is recommended that the test equipment be capable of taking variable data even if the supplier intends to use it on an attribute (i.e., go, no-go) basis. Fixture to be agreed upon between customer and supplier.
- 4.1.1.2 Fixturing should protect the part from damage during testing.
- 4.1.1.3 The fixture should restrain the fuel tank in a similar fashion as in the vehicle.

4.1.2 INSTRUCTIONS FOR SETTING UP THE TEST

- 4.1.2.1 At the start and finish of each shift, each test fixture should be checked to verify that its calibration remains within acceptable limits and it is still capable of detecting leaks that are at the specified acceptance criteria limits for the parts being tested.

4.1.2.2 The supplier is advised to have available with each fixture, test parts containing actual manufacturing defects resulting in leaks that the fixture can detect.

4.1.2.3 The supplier of fuel tanks should follow the leak test equipment manufacturers recommended maintenance requirements.

4.1.3 INSTRUCTIONS FOR CONDUCTING THE TEST

4.1.3.1 Assembly aid lubricants, adhesives, oil residue from prior metal working operations, etc. can mask the presence of leaks in the interface between mating portions of a joint or connection. Wherever practical, use of these substances should be eliminated from parts used to establish process capability. The use of these substances makes reliance on 100% leak testing impractical. SPC methods based on leak prevention are the only reliable approach to producing leak free components and modules.

4.1.3.2 It is recommended that the test method measure variable data in support of an SPC approach to leak prevention rather than a straight attribute test on a 100% basis. The PV test program should fully support the IP test process used.

4.1.3.3 The fuel tank manufacturer is responsible for developing detailed test instructions for each leak test fixture and having them available at the machine.

4.1.3.4 Employees responsible for conducting or maintaining fuel system leak test equipment should be fully trained.

4.1.3.5 *Acceptance Criterion*

No leak paths through the sender cover or its gasket greater than the equivalent of a 15μ diameter channel x 3 mm long. See Appendix C at end of document.

4.2 Permeation Resistance

4.2.1 TEST EQUIPMENT

Mini-SHED or micro-SHED.

4.2.2 SAMPLE PREPARATION

4.2.2.1 Closure design being evaluated should be produced using production intent tooling.

4.2.2.2 Test design is to attempt to measure the SHED losses from the closure and gasket alone by subtracting out the hydrocarbon loss contribution due to permeation from the portion of the tank included in the test sample.

4.2.3 TEST METHOD

Test fluid to be SAE J1681 test fluid CE10 (ASTM ref. Fuel C and 10% Ethanol by volume) or TF-1.

- 4.2.3.1 Test temperatures to be constant temperature of 40 °C or 60 °C.
- 4.2.3.2 Precondition the test sample(s) at the intended test temperature until steady state permeation has been reached before SHED measurement. Verify by test that steady state permeation has been reached using SAE J1737 methodology. Measure and record the hydrocarbon losses in gram/h or grams/day whichever is permitted by the accuracy of the test equipment at the hydrocarbon loss rate being detected.
- 4.2.4 ACCEPTANCE CRITERION
 - 4.2.4.1 Final acceptance to be established by mutual agreement between customer and supplier.
 - 4.2.4.2 For reference: appropriate LEV-I/US Tier 1/EU Stage 3 & 4, emission targets for the sender cover and gasket should be less than 40 mg/24 hour @ 40 °C.
 - 4.2.4.3 For reference: appropriate LEV-II(Near Zero) / US Tier 2 / EU Stage 5 emission targets for the sender cover and gasket should be less than 10 mg/24 hour @ 40 °C.

4.3 Static Pressure Resistance

This test evaluates the ability of fuel tank closure systems to withstand hydrostatic pressure. This test may be performed using production fuel tanks, prototype tanks simulating production intent or samples made from that portion of a tank containing the closure system. Fuel tanks need only have those openings necessary to perform this test.

4.3.1 TEST EQUIPMENT

- 4.3.1.1 Suitable hydraulic test equipment capable of supporting test tank filled with water and contain the water if a tank is tested beyond its capability.
- 4.3.1.2 System to pressurize the tank using water. Water delivery system utilizing a positive displacement pump sized at a rate of 38 L/min plus/minus 20%.
- 4.3.1.3 Means to measure and record fuel tank internal pressure (accurate to ± 5.3 kPa) vs. time (accurate to ± 0.1 sec) during the test.

4.3.2 SAMPLE PREPARATION

- 4.3.2.1 Minimum of three tanks required.
- 4.3.2.2 Test samples should be stabilized by aging at room temperature for a minimum of 48 hours after molding.
- 4.3.2.3 Fill the tank as completely as possible with water.
- 4.3.2.4 Install gasket, cover and retainer to production intent specified tightness (e.g. torque, deflection, etc.).