

Optimized Fuel Tank Sender Closure**TABLE OF CONTENTS**

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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 15 μ 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.).

4.3.2.5 Place the filled and sealed fuel tank into test chamber. The tank is to be unrestrained and free to deform. Tank is to be situated to facilitate video capture of initial leakage.

4.3.2.6 Attach hydraulic pressurization device. Sender cover should be modified for this purpose.

4.3.3 TEST METHOD

4.3.3.1 Apply pressure at pump volume until the closure system loses seal integrity or the tank itself loses integrity.

4.3.3.2 If a portion of the tank or test sample leaks before the closure system, the test is to be voided.

4.3.3.3 Record the pressure. Video during the test is optional.

4.3.3.4 Record the following:

4.3.3.4.1 Pressure at which leakage occurs from the closure system being tested.

4.3.3.4.2 Sample I.D.

4.3.3.4.3 Part Number.

4.3.3.4.4 Cavity Number.

4.3.3.4.5 Date of Manufacture.

4.3.4 ACCEPTANCE CRITERION

4.3.4.1 *Recommended*

Tank and closure should withstand a minimum of 240 kPa (35 psi) without detectable liquid leak.

4.3.4.2 Final acceptance to be established by mutual agreement between customer and supplier.

4.4 Retainer Tightening

Closure design should achieve design intent sealing below the maximum allowed value and should be tolerant of 50% higher tightening force than required for proper installation.

4.4.1 TEST EQUIPMENT

4.4.1.1 Suitable device that can support the approved assembly plant tightening tool for the closure design being tested and apply the tighten force.

4.4.1.2 A means for restraining the tank or test sample to permit applying the required amount of torque or force to tighten the closure.

4.4.1.3 A means of measuring and recording the tightening force and rotation.

4.4.2 SAMPLE PREPARATION

- 4.4.2.1 This test is to be conducted on closure systems produced using production intent tooling. This test may be performed using production fuel tanks, test 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.

4.4.3 TEST METHOD

- 4.4.3.1 Obtain manufacturers recommended tightening procedure and recommended degree of tightness specified for use with the design being evaluated.
- 4.4.3.2 Apply the force (or torque or impact energy, etc.) necessary to install and tighten the closure to the specification tightened/sealed position.
- 4.4.3.3 Record the force required (or torque or impact energy, etc.).
- 4.4.3.4 Conduct tests 4.1.
- 4.4.3.5 Apply a tightening force (or torque or impact energy, etc.) 50% greater than that specified in the assembly process specification within 10 seconds. If it is a force or torque hold it for 1 second then release.
- 4.4.3.6 Conduct tests 4.1 and 4.3.

4.4.4 ACCEPTANCE CRITERIA

- 4.4.4.1 Should meet the requirements of 4.1 and 4.3.
- 4.4.4.2 After applying force (or torque or impact energy, etc.) 50% above specification there should be no evidence of cracking, tearing or permanent deformation of the fuel tank or retainer system.

4.5 Resistance to Damage from Electrostatic Charge – Design Guideline

- 4.5.1 The closure cover should be designed so that it meets the component recommendations of SAE J1645.

4.6 Strength in Bending

(Resistance to forces induced during crash which might cause the sender cover to bend up or down and locally disturb the tank to cover gasket).

4.6.1 TEST EQUIPMENT

- 4.6.1.1 Standard tensile/compression test device or other side load device with strain gauge capable of applying 10 kN forces with a speed of 50 mm per minute.
- 4.6.1.2 Means for measuring and recording applied force vs. deflection with 1% accuracy.

- 4.6.1.3 A plate that simulates the design intent sender cover with a 25 mm bar connected through its center extending outward from the tank opening. The bar is to be 200 mm long.
- 4.6.1.4 A mean for restraining the tank or test sample to resist a force of 10 kN applied perpendicularly to the bar at a point 160 mm from the plate surface.
- 4.6.1.5 A means for applying 14 kPa (2 psi) pressure to the test tank or to the interior side of the test sample.
- 4.6.1.6 A means for monitoring pressure in the tank that is accurate to within ± 1.0 kPa.

4.6.2 SAMPLE PREPARATION

- 4.6.2.1 Install the test cover to the fuel tank or test sample and tighten the closure system to specification.
- 4.6.2.2 Pressurize the fuel tank or sample to the pressure agreed upon by customer and supplier. For example 14 kPa (2 psi).
- 4.6.2.3 Install the test sample in its restraint in a tensile tester so that the crosshead is aligned with the bar at a point 160 mm from the test cover surface.
- 4.6.2.4 Connect a load link to the bar between the bar at the 160 mm point and the crosshead.

4.6.3 TEST METHOD

- 4.6.3.1 Apply a load to the bar in the test cover at a crosshead speed of 50 mm/minute.
- 4.6.3.2 Record the load vs. displacement during the test.
- 4.6.3.3 Record the pressure vs. time during the test.
- 4.6.3.4 Increase the load until the closure gasket is disrupted indicated by a pressure drop.

4.6.4 ACCEPTANCE CRITERION

4.6.4.1 *Recommended*

No leak detected at loads up to 450 N applied at 160 mm point on bar. (Could be a fixed force at failure or a maximum deflection at some fixed force.)

- 4.6.4.2 Final acceptance to be established by mutual agreement between customer and supplier.

5. Tests to Assess Robustness Against Vehicle Impact Events

During vehicle impact tests, the fuel tank can be subjected to a number of different force mechanisms that have the potential to cause the sender closure system to leak or break. The circumstances that might result in leakage from the sender closure during or after a vehicle impact are dependant on many aspects of the total design such as:

The tank design itself
The relative placement of the sender closure within the envelope of the tank
The design of the vehicle structure surrounding the tank
The mean by which the tank is retained within the vehicle
The presence or absence of shields
The manner in which in-tank components are attached to the closure
Etc.

It is the responsibility of the vehicle OEM to assess all aspects of the fuel tank and vehicle design to assure the integrity of the fuel system in the event of reasonably severe vehicle impacts.

6. Durability Tests

The following tests provide baseline qualification for durability to fuel pump module/sender attachment designs in environmental and chemical exposure. This does not validate the design for its application within a specific fuel tank and vehicle. Validation requires vehicle system durability testing and must be established between customer and supplier.

Typical durability test may include but not limited to, pressure vacuum and vibration test.

The minimum test sample size of three is recommended.

6.1 Fuel Exposure

6.1.1 TEST EQUIPMENT

6.1.1.1 Suitable for safely heating and maintaining test fuel tanks containing volatile test fluids at exposure temperature for extended periods of time.

6.1.2 SAMPLE PREPARATION

6.1.2.1 Conduct test on fuel tank and closure system produced using production intent tooling. Test fuel tank need only have those openings necessary to perform this test.

6.1.2.2 Test tank to be equipped with a means for adding and removing fuel that does not disturb the closure system being tested.

6.1.2.3 Installs test closure system into the test tank and tighten to design-intent assembly-process specification.

6.1.3 TEST METHOD

- 6.1.3.1 Test fluids to be SAE J1681 (2000 rev.) C(M15)A, C(ME15), CP or Diesel fuel plus 10% Soy Methyl Ester & Fuels (TF1 and/or TF2).
- 6.1.3.2 Fill tank to 20% rated capacity with the intended test fluid.
- 6.1.3.3 Position the tank so that the fuel inside covers the closure to approximately $\frac{1}{2}$ its diameter.
- 6.1.3.4 Place the tank into the controlled temperature exposure chamber for 1000 hrs at 60 °C.
- 6.1.3.5 After exposure, remove the fuel tank, allow it to reach room temperature and drain the test fluid.

6.1.4 ACCEPTANCE CRITERIA

- 6.1.4.1 The fuel tank or test sample should not leak when tested with leak test specification of Appendix C.
- 6.1.4.2 A nitrogen or helium decay leak method is recommended.

NOTE—Fuel residue in the fuel tank or test sample may contaminate a closed helium leak tester.

6.2 Temperature Cycling

6.2.1 TEST EQUIPMENT

- 6.2.1.1 Environmental Chamber suitable for safely heating and maintaining test fuel tanks containing test reference fuels at a minimum of 40 °C for tank conditioning period.
- 6.2.1.2 Environmental chamber(s) capable of achieving -40 °C and 95 °C and of suitable size to hold a test fuel tank in a fixture that represents in-service retention of same test tank.
- 6.2.1.3 Equipment or means to rotate or invert tank in fixture 180°.
- 6.2.1.4 Leak testing equipment capable of meeting requirements in 4.1.

6.2.2 SAMPLE PREPARATION

- 6.2.2.1 Conduct test on 3 fuel tanks with closure systems with production representative components. Test fuel tank need only have those openings necessary to perform this test.
- 6.2.2.2 Test tank to be equipped with a means for adding and removing test fluids that will not disturb the closure system being tested, or require it's disassembly during the test.
- 6.2.2.3 Install test closure system into the test tank. Tighten to design intent specification using design intent assembly process.
- 6.2.2.4 Leak Test Fuel tank to the requirements of 4.1.

6.2.3 TEST METHOD

- 6.2.3.1 Fill tank to 40% of Rated Capacity with CE10 or TF1 per SAE J1681 and soak tank for six (6) weeks at a minimum of 40 °C, vented.
- 6.2.3.2 (Optional) Leak test to requirements in 4.1.
- 6.2.3.3 Drain tank of fuel and refill with a volume of water 60/40 water/Ethylene or Propylene glycol mix equivalent to 40% of total internal volume of the tank shell. Allow tank and water to stabilize to Ambient (23 °C).
- 6.2.3.4 Fixture test tank to test fixture and place into thermal chamber.
- 6.2.3.5 Heat test tank until tank and liquid reach +95 °C (+ 2 °C) and hold for one hour.
- 6.2.3.6 (Optional) Remove tank and conduct Leak Check after return to ambient.
- 6.2.3.7 Allow tank to return to ambient temperature (23 °C).
- 6.2.3.8 Introduce fixtured tank into a -40 °C thermal chamber and soak for 12 hours.
- 6.2.3.9 Either a) remove fixtured tank from thermal chamber and place into an ambient chamber @ 23 °C (+ 2 °C), or b) increase thermal chamber temperature to 23 °C (+ 2 °C), and allow tank to thermal soak for 12 hours.
- 6.2.3.10 Repeat 6.2.3.8.
- 6.2.3.11 At the end of the second -40 °C thermal soak, remove tank from thermal chamber and invert 180° to simulate roll-over. Time set-up should not be longer than 4.5 minutes from removal from thermal chamber. Rotation time should not exceed 30 seconds.
- 6.2.3.12 Check interface for liquid leak for a period of 2 minutes.
- 6.2.3.13 Rotate tank to vehicle position and allow system and fluid to return to ambient temperature.
- 6.2.3.14 Leak check tank per recommended practice in Appendix A.

6.2.4 ACCEPTANCE CRITERION

- 6.2.4.1 Tank should meet the requirements of 4.1 and 4.3.

NOTE—This test procedure would require 8 weeks to generate 3 histograms/data points.

6.3 Resistance to Corrosion

6.3.1 TEST EQUIPMENT

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

6.3.2 SAMPLE PREPARATION

- 6.3.2.1 Sender opening should be production intent design in its intended fuel tank design, or a production intent sender opening might be fabricated into a small test tank.
- 6.3.2.2 Install test closure system into the sender opening of the test tank and tighten to design intent assembly process degree of tightness.

6.3.3 TEST METHOD

Expose closure samples to 1000 hours of salt spray per ASTM B 117-03.

- 6.3.4 Rinse off the samples using warm water to remove excess salt and debris being careful not to disturb the closure gasket and retainer.
- 6.3.5 Evaluate closure in accordance with 4.1 and 4.3.
- 6.3.6 After evaluation per 6.3.5, disassemble the closure and reinstall it using a new gasket.
- 6.3.7 Evaluate the closure per 4.1.

6.3.8 ACCEPTANCE CRITERIA

- 6.3.8.1 Immediately after salt spray the closure should meet the requirements of 4.1 and 4.3.
- 6.3.8.2 After service disassembly and replacement the closure should meet the requirements of 4.1.

6.4 Resistance to External Chemical Environment

6.4.1 TEST EQUIPMENT

6.4.2 SAMPLE PREPARATION

- 6.4.2.1 Sender opening should be production intent design in its intended fuel tank design, or a production intent sender opening might be fabricated into a small test tank.

- 6.4.2.2 Install test closure system into the sender opening of the test tank and tighten to design intent assembly process degree of tightness.

Test fluids: per SAE J2027 (Concentration Time Temperature)

Aggressive Water ¹	(100% 70 h 40 °C)
Calcium Chloride	(10% 70 h 40 °C)
Sodium Chloride	(10% 70 h 40 °C)
Zinc Chloride	(50% 168 h 24 °C)
Brake Fluid	(100% 1 h 100 °C, air dry)
Ethylene Glycol	(50% 1 h 100 °C, air dry)
Fuel C	(100% 1 h 40 °C, air dry)
IRM 903 Oil	(100% 1 h 40 °C, air dry)
Transmission fluids	(100% 1 h 40 °C, air dry)

6.4.3 TEST METHOD

- 6.4.3.1 Exposure temperature to be 60 °C.

- 6.4.3.2 After completion of the chemical/temperature exposure, rinse off the samples using warm soapy water to remove chemical residue and debris, being careful not to disturb the closure gasket and retainer.

6.4.4 ACCEPTANCE CRITERION

- 6.4.4.1 The closure should meet the requirements of 4.1 and 4.3.

- 6.4.4.2 Surrogate test data of subcomponents and/or material may be utilized to meet this requirement.

6.5 Assembly/Disassembly Fatigue

6.5.1 TEST EQUIPMENT

- 6.5.1.1 Ordinary repair shop tools used to service sending units or tools recommended by manufacturer to be used for service.

6.5.2 SAMPLE PREPARATION

- 6.5.2.1 Sender opening section may be cut from production intent fuel tank or a production intent sender opening may be fabricated into a small test tank.

- 6.5.2.2 Install test closure system into the sender opening of the test tank or tank section and tighten to design intent assembly process degree of tightness.

6.5.3 TEST METHOD

- 6.5.3.1 Remove the sender unit closure retainer and remove the closure from the tank.

¹ (1.0 L of distilled water with 0.990 g NaCl (600 ppm CL), 0.888 g Na₂SO₄ (600 ppm SO₄) and 0.828 g NaHCO₃ (600 ppm HCO₃))

6.5.3.2 Wait at least 5 minutes.

6.5.3.3 Reinstall the closure and retainer and retighten to degree of tightness specified in the authorized repair manual.

6.5.3.4 Wait at least 5 minutes.

6.5.3.5 Repeat 6.5.3.1 thru 6.5.3.4 four (4) additional times.

6.5.4 ACCEPTANCE CRITERION

After service disassembly and replacement five times the closure should meet the requirements of 4.1. If the application requires (such as in recommended service procedures) replace some of the components before repeating the test.

PREPARED BY THE SAE FUEL TANK CONNECTION TASK FORCE

APPENDIX A STANDARD DIMENSIONS AND FEATURES

Tolerances need be defined for specific application. Alternative designs must be completely compatible with Figure A1 and its dimensions. Refer to Figures A1, A2 and A3 for description of symbols.

TABLE A1—STANDARD DIMENSIONS

Dimension Symbol	Description	Dimension Value for 130.5 mm Nominal Design (mm)	Dimension Value for 115.5 mm Nominal Design (mm)	Dimension Value for 95.5 mm Nominal Design (mm)
A _c	Closure Inner Alignment Diameter	129.50	114.50	94.50
A _T	Fuel Tank Aperture Diameter	130.50	115.50	95.50
B	Closure O.D.	152.00	137.00	119.00
C	Locking Ring Pilot Feature Diameter	122.00	107.00	87.50
D	Locking Ring Pilot Feature Height	7 min.	10 min.	7 min.
E	Closure Flange Thickness	3.00	3.00	3.00
F	Closure Alignment Skirt Length	12 min.	12 min.	17 min.
G	Closure Gasket I.D.	135.50	120.00	100.50
H	Closure Gasket Width (Cross Section Diameter for 'O' ring)	6.00	6.00	6.00
J	Tank Gasket Gland Depth	3.30	3.30	3.30
K	Gasket Gland I.D.	134.50	119.50	99.50
L	Gasket Gland Width	7.75	7.75	8.00

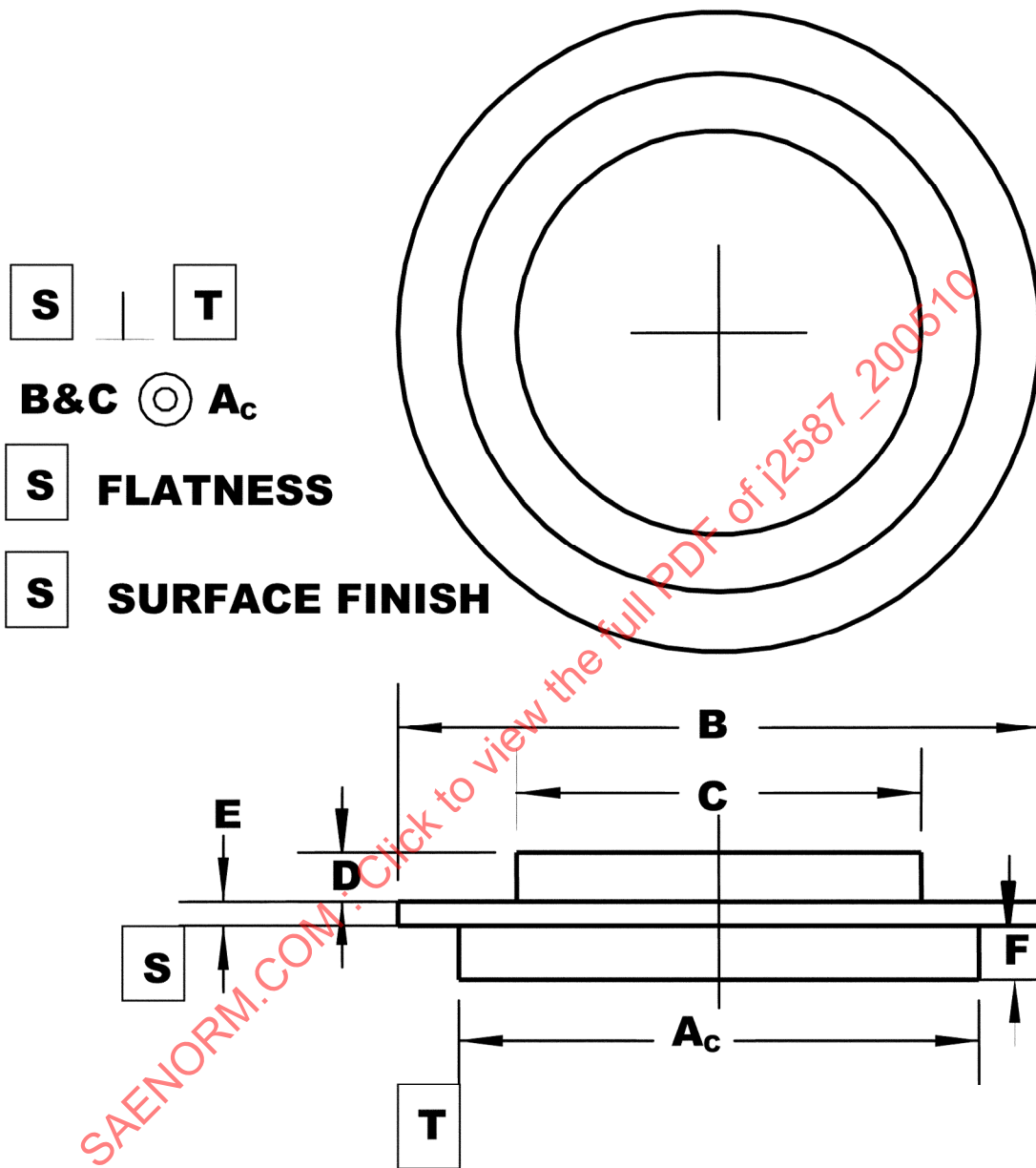
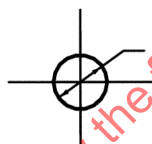
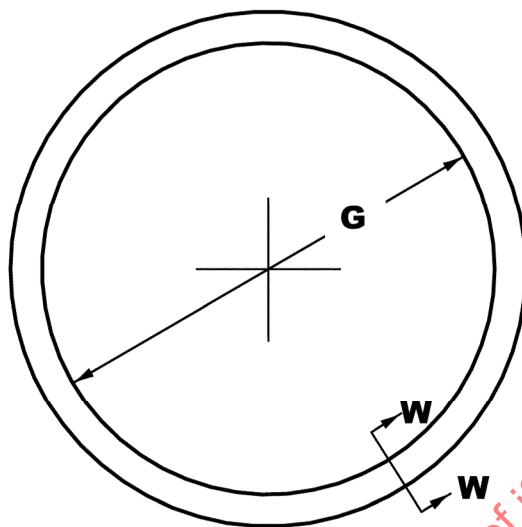


FIGURE A1—CLOSURE COVER FLANGE



DETAIL: SECTION W-W

FIGURE A2—CLOSURE GASKET