



PERFORMANCE REQUIREMENTS FOR BODY PLUGS

1. SCOPE

This specification covers the performance requirements for automotive-use body plugs required to close out sheet metal holes and slots. Performance is covered in the following sections for insertion efforts, extraction efforts, dynamic water tightness, static water tightness, material aging, paint oven compatibility, sound transmission loss, fire ingress, adhesion of underbody materials, sheet metal tolerances, and paint build up tolerance requirements.

2. REFERENCES

Ford Motor Company (FMC) Systems Design Specification (SDS) Trustmark Requirement BY-0053 Standard Circular & Slotted Sheet Metal Hole Sizes for Plugs
WSD-M9P8-A Rubber Parts, Interior and Exterior Performance
WSS-M99P31-A1/A2/A3 Performance Sprayable Coating, Acoustic, Interior and/or Exterior, Body Panels
FLTM BO 160-04 Resistance of Painted Plastic Parts to High Pressure Cleaning Operations
ISO 6270-2 Paints and Varnishes - Determination of Resistance to Humidity
ISO 286-1 ISO System of Limits and Fits
FMC Directive E-108: Global Automotive Parts Trademarks
FMC Engineering CAD & Drafting Standards - E3 and E4

3. BODY PLUG DESIGN VERIFICATION

All sheet metal body plugs released for FMC products, shall be designed using the standard circular and slotted sheet metal hole size steps as stated in SDS BY-0053. All sheet metal body plug applications shall incorporate the design guidelines released in SDS BY-0053 Detail WM910 Supplement - Worldwide Plug and Tape Application Standard by Design Condition. A specific design condition and recommended body plug design/material shall meet the necessary performance requirements as defined with the design verification lab methods in this standard. A specific condition may require that some or all of the verification tests be performed to determine acceptability. It is also acceptable to use Computer Aided Engineering (CAE) to perform benchmark testing against existing parts that have achieved acceptability. Additional design and process guidelines may also be found using the FMC SDS.

4. QUALITY

All sheet metal body plugs shall function over the life of the vehicle. There must be no significant defects such as voids or parting lines against the sealing surface and inconsistent color or staining that is detrimental to the function or appearance of the body plug.

Body plug performance requirements support assembly without an installation tool or a lubricant. A lubricant will affect performance, although a general lubricant, ESE-M99B144-B (Merpol), can be used. Body plugs should not come into contact with any hydrocarbon lubricants or mineral oil based products (e.g. engine oil or WD-40). Body plugs applied in the Paint shop should also avoid silicone based lubricants (e.g. P-80).

It is recommended that body plugs are located a minimum distance of 25 mm away from any soft sealer joint, in order to prevent inference from a squeeze out condition.

It is recommended that body plugs are installed in the direction where the greatest external forces are applied, in order to resist these forces with a body plug force through condition. External forces can result from the customer's foot, stone pecking, and down stream processes such as sprayable under coating.

5. GENERAL CONDITIONS OF TEST

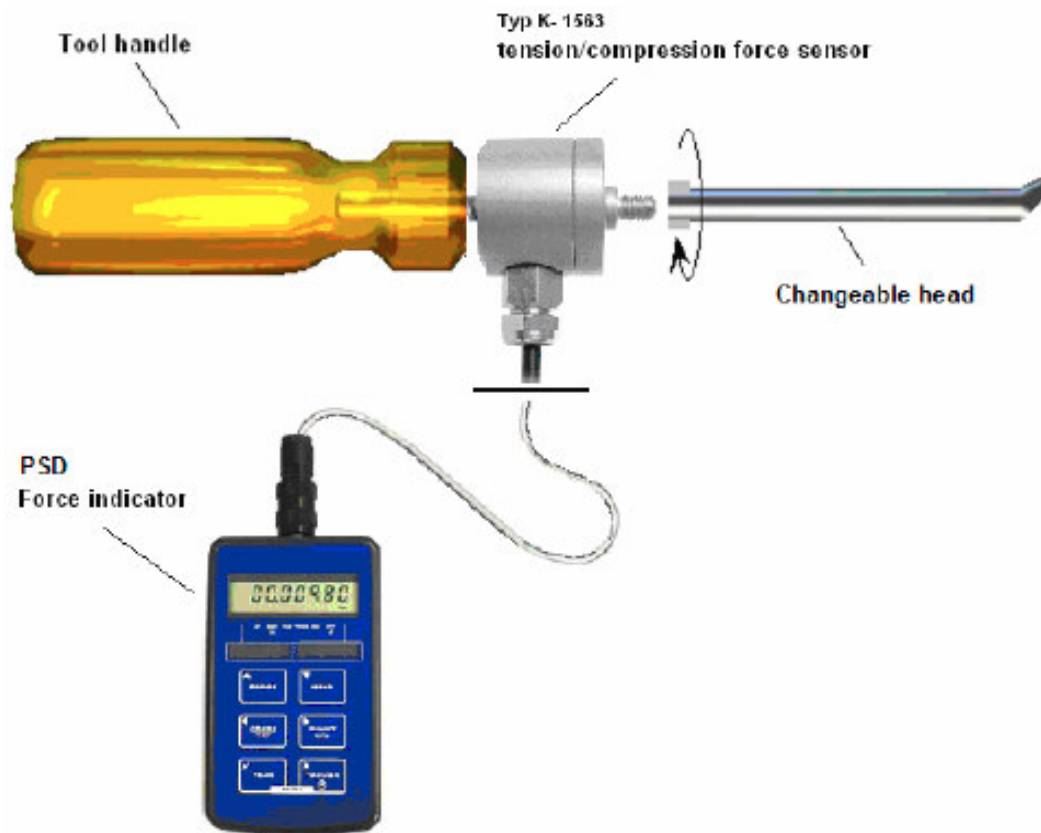
All sheet metal body plugs will be tested using Aluminum, or Steel plates that have been e-coated with a similar process as used in production at FMC. The standard steel sheet metal minimum and maximum plate thicknesses shall be 0.6 mm, and 2.0 mm, respectively. For aluminum sheet metal, the minimum and maximum plate thicknesses shall be 0.8 mm, and 3.0 mm, respectively. Test plates shall be manufactured using a punch operation or process that is similar to the one used in production at FMC. Holes or slots shall not be chamfered or deburred.

6. INSERTION EFFORTS

This requirement covers the performance characteristics to evaluate the force required to assemble a body plug into a sheet metal hole or slot, by hand or finger.

TEST EQUIPMENT: An electronic force indicator with an integrated installation tool and force gauge such as the Lorentz Messtechnik GM80 equipment as shown in Figure 6-1. A holding fixture to secure the test plates in a horizontal position.

Figure 6-1



TEST PROCEDURE: Use the installation tool to install the un-lubricated body plug into the sheet metal hole or slot, with a skilled operator. The tool's changeable head shall be selected to simulate production conditions, and can be altered based on the design of the body plug. The operator will install the body plugs with the installation tool in the vertical direction with a straight arm and wrist, as shown in Figure 6-2.

Figure 6-2



The operator shall use the minimum amount of pressure to install the body plug. If excessive pressure is used, the installation should be redone. Measure the force over the entire installation process to assemble the body plug. Fifteen samples are required for each test condition to determine the average maximum force.

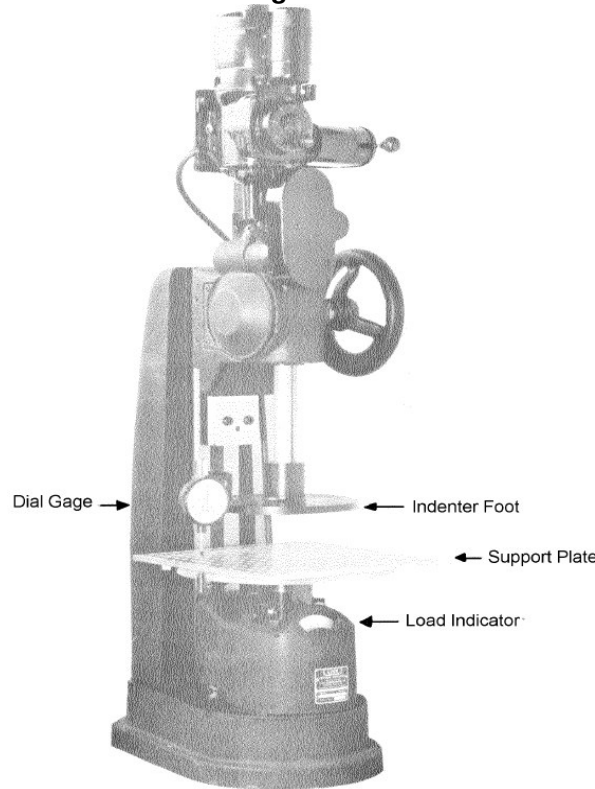
PERFORMANCE REQUIREMENTS: Maximum force shall not exceed 87 N, and the maximum installation time shall not exceed 1.5 seconds.

7. EXTRACTION EFFORTS

This requirement covers the performance characteristics to evaluate the force required to extract the body plug from a sheet metal hole or slot.

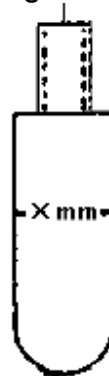
TEST EQUIPMENT: A tensile test machine with compression capability, as shown in Figure 7-1.

Figure 7-1



Push out punches with a radius contact point as shown in Figure 7-2, sufficiently sized in order to carry out the tests to allow the body plug to pass through freely without snagging.

Figure 7-2



The punch size shall be at least 10% below the actual sheet metal hole or minimum slot size. A holding fixture and backing plate shall be used so that only the body plug will take the test load.

TEST PROCEDURE: The body plug shall be assembled to the test plate. The plate shall be designed to the largest sheet metal thickness application (2.0 mm reference). An unused body plug shall be extracted in both directions, using a compressive punch force at the center of the body plug. The compressive punch force shall be applied at a rate of 50-100 mm/minute. The maximum extraction force shall be recorded for both directions. The mode of failure should be recorded. Five samples are required for testing.

PERFORMANCE REQUIREMENTS: Maximum extraction force shall be greater than 30 to 100 N, depending on the application and location of the body plug.

8. DYNAMIC WATER TIGHTNESS

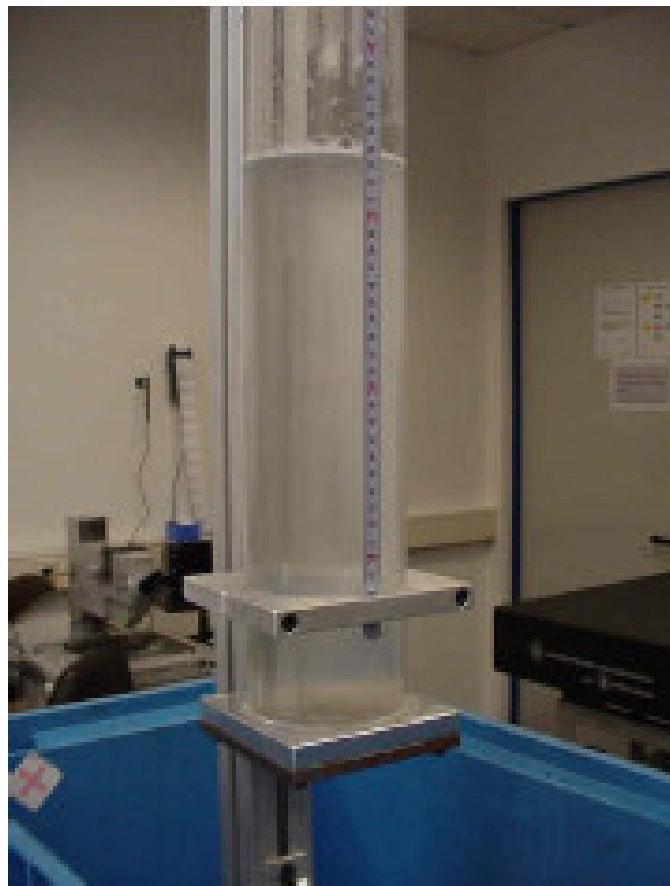
This requirement covers the performance characteristics to evaluate the water tightness of assembled body plugs during a vehicle car wash, as well as from rain incurred during vehicle driving conditions. The Static Water Tightness test shall be used to verify this requirement, so that no additional testing is required.

9. STATIC WATER TIGHTNESS

This requirement covers the performance characteristics to evaluate the water tightness of assembled body plugs from water puddles incurred during vehicle driving conditions.

TEST EQUIPMENT: A water column that is large enough and fitted to seal and install the test plate, as shown in Figure 9-1.

Figure 9-1



The water temperature shall be 25 +/- 5 °C. The test plate attachments must be sealed to ensure water tightness. A digital camera shall be used when required to document the results.

TEST PROCEDURE: The body plug shall be assembled to the test plate and then installed on the bottom of the water column. The plate shall be designed to the smallest sheet metal thickness application (0.6 mm reference). The body plug shall be assembled in both directions on the test plate, and tested for each installation direction. The water column will be filled with water to a minimum height of 30 cm, and subjected to the body plug for 2 hours. The dry side of the test plate will be inspected for any water leak condition. The