CHO-TM201
July/1992

Shielding Effectiveness Measurement of EMI Gaskets and Flange Treatments Subjected to Salt Fog Exposure (20″ x 20″ Aperture)

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1.0 **SCOPE**

1.1 This is a test method for performing shielding effectiveness measurements on EMI gaskets and flange treatment systems before and after multiple cycles of environmental exposure. This test method is intended to allow evaluation of shielding effectiveness of different flange treatments, gasket materials and configurations after each cycle of environmental exposure. Radiated methods in accordance with MIL-STD 285, except where noted, are used to determine shielding effectiveness.

1.2 The test method covers selection of materials, specimen preparation, test setup and instrumentation for performing shielding effectiveness measurements and environmental exposure, and methods of reporting results.

2.0 **APPLICABLE DOCUMENTS**

2.1 ASTM Standards

2.1.1 ASTM 8117: Method of salt spray (fog) testing

2.2 Military Standards

2.2.1 MIL-STD-285: Attenuation measurements for enclosures, electromagnetic shielding, for electronic test purposes; method of.

2.2.2 MIL-C-5541E: Chemical conversion coatings on aluminum and aluminum alloys.

2.2.3 MIL-G-835288: Gasketing material, conductive shielding gasket, electronic, elastomer, EMI/RFI general specifications for.

2.2.4 MIL-STD 202: Test methods for electronic and electrical component parts

2.2.5 MIL-STD 45662: Calibration systems requirements

2.3 Additional Specifications

2.3.1 NSA 65-6: National Security Agency specification for R.F. shielded enclosures for communications equipment: General Specification

3.0 SIGNIFICANCE AND USE

3.1 Conductive EMI gaskets are used to seal seams in electronic enclosures and airframes against leakage of electromagnetic radiation. Such gaskets typically contain metal powders, fabrics o. wires, including silver, monel, tin-plated copper clad steel, nickel, silver-plated aluminum, or other metals which generally are not galvanically compatible with their mating flanges.

3.2 Exposure of EMI gasket/flange combinations to harsh environments (e.g., corrosive, high temperature, or fuels etc.) may result in physical or electrical degradation of the gasket or mating flange or both, which can lead to a loss of shielding effectiveness.

3.3 The purpose of this test procedure is to determine the shielding effectiveness of EMI gasket/flange combinations before and after environmental exposure.

3.3.1 The shielding effectiveness is measured using a radiated field technique. The measurement technique is a slightly modified version of MIL-STD-285.

3.3.2 The test gasket and flange (or "test set") is designed so that shielding effectiveness measurements and environmental exposure can be performed without disassembly of the "test set".

3.4 This procedure is intended to provide a controlled test for comparison of different gasket/coating combinations. It cannot be used to predict the shielding performance of EMI gaskets in actual enclosure flanges, due to the effects of flange design, gasket shape, compression forces, etc. The values obtained apply only to the particular gasket/flange geometry and simulated environmental conditions tested.

adapter plate must match the test aperture and bolt pattern on the shielded enclosure (test chamber). The outer bolt pattern matches the bolt pattern on the shielded enclosure wall. The inner bolt pattern

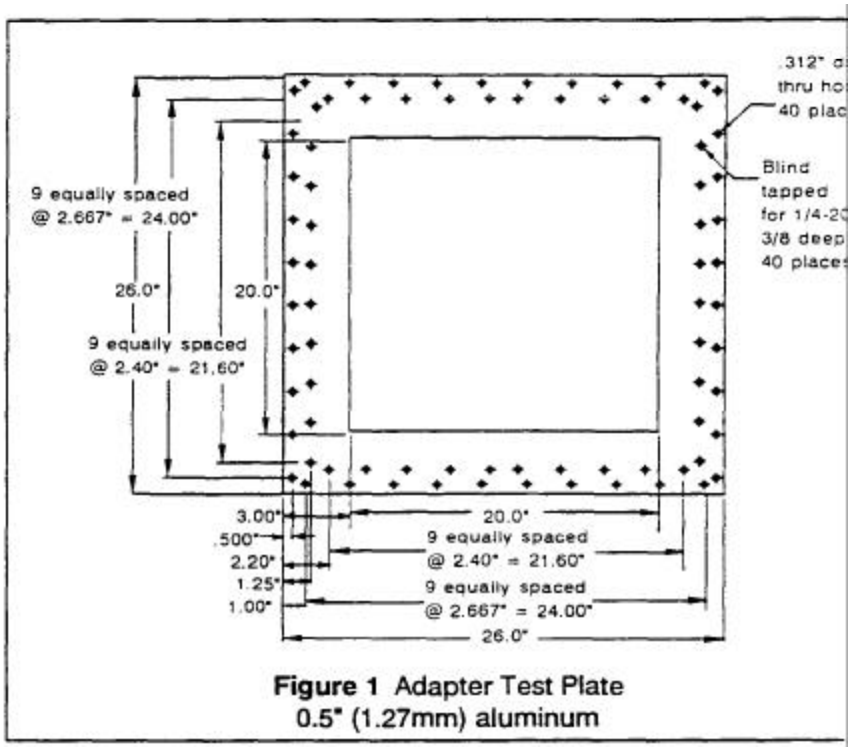

Figure 1 Adapter Test Plate
0.5" (1.27mm) aluminum

matches the cover test plate. The adapter test plate is 0.5 inch (12.7mm) thick T606' T6 aluminum.

4.0 TEST SAMPLE PREPARATION

4.1 Test Plates

4.1.1 Two test plates are required to perform the shielding effectiveness and environmental tests. Each "test set" consists of an adapter plate, a cover plate, a test gasket, non-conductive compression stops and mounting hardware.

4.1.2 Adapter Test Plate

The adapter test plate (see Figure 2) is one half of the test set. The

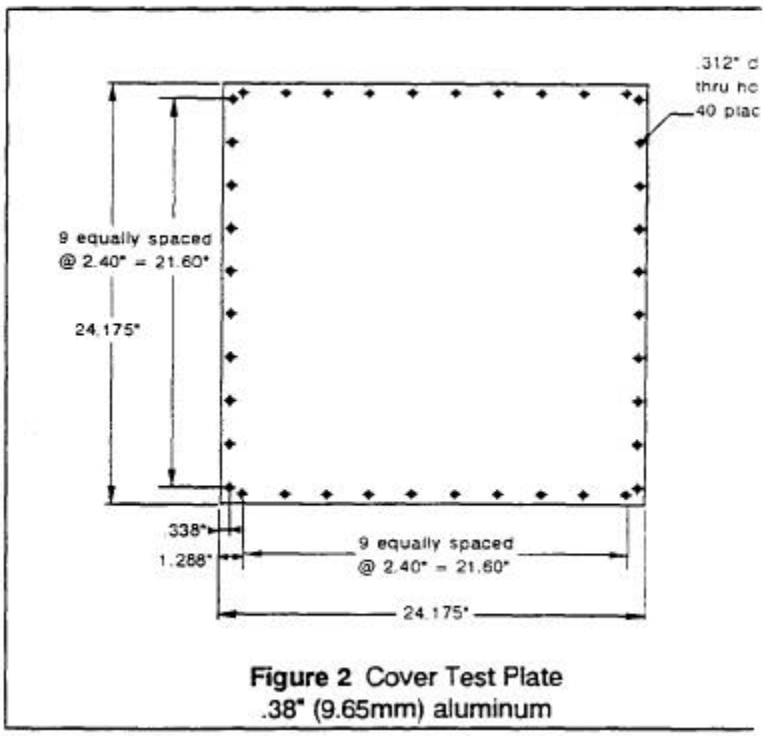

Figure 2 Cover Test Plate
.38" (9.65mm) aluminum

4.1.4 Cover Test Plate

The cover test plate (see Figure 2) is the matching half of a test set. The bolt pattern matches the inner bolt pattern on the adapter test plate described previously. The cover test plate is 0.38 inch (9.65mm) thick 6061T6 aluminum. The test plates are sized so that the test set (one adapter test plate and one cover test plate) could be placed within an environmental test chamber. This allows alternating environmental exposures and shielding effectiveness tests to determine the shielding degradation, if any, due to increasing durations of environmental exposure. In addition, it allows the shielding tests to be performed without disassembling the test sets.

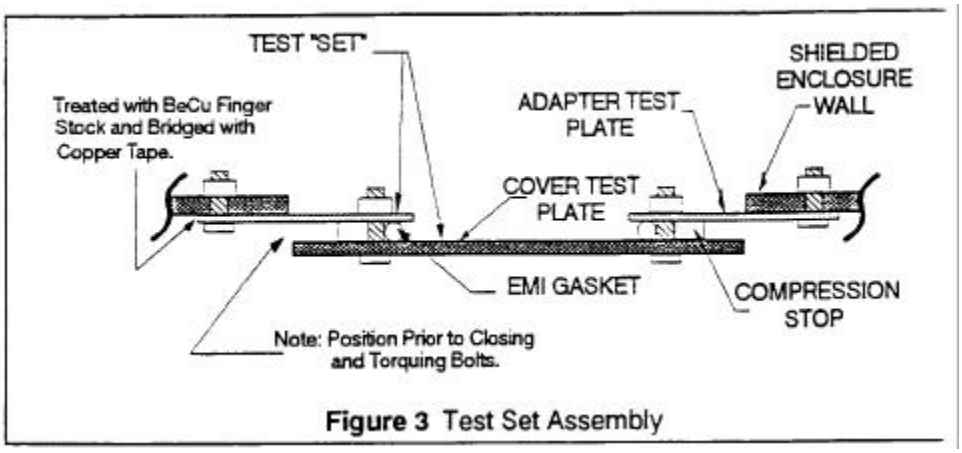

Figure 3 Test Set Assembly

4.1.5 The complete test set assembly is illustrated in Figure 3.

4.1.6 Compression stops are utilized between the two test plates which make up the "set". These non-conductive "spacers" are sized to assure the recommended amount of deflection of the test gasket.

4.2 EMI Gaskets

4.2.1 The test gasket should be in the form of a square "picture frame" with an outside dimension of approximately 21.75 inches (55.24cm) and an inside dimension of approximately 20.25 inches (51.44cm). It can be die cut from sheet stock or assembled from strips and spliced with a conductive compound at the four corners.

4.3 Test Plate Preparation

4.3.1 This test procedure is intended to allow shielding effectiveness evaluation of EMI gaskets mated against a variety of conductive flange treatments.

4.3.2 For general protection of the aluminum flanges, a MIL-C-5541, Class 3 chromate conversion coating is applied. Various conductive coatings can also be Applied for additional corrosion protection

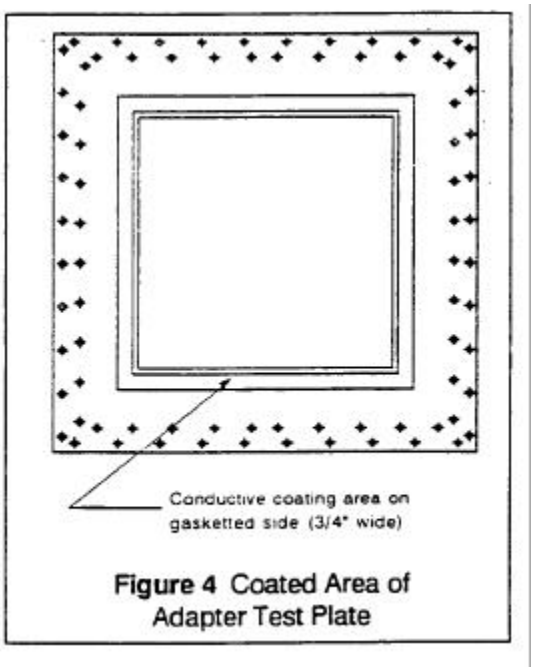

Figure 4 Coated Area of Adapter Test Plate

and to enhance compatibility with the gasket material in accordance with the following procedures:

4.3.2.1 The conductive coating is applied on the adapter test plate (Figure 4) .125 inches (3.175mm) from the aperture edge (20.25 inch square [51.44 cm]) in a .75 inch (1.91 cm) width around the test plate (21.75 inch square [55.24 cm]), on the side to be mated with the test gasket.

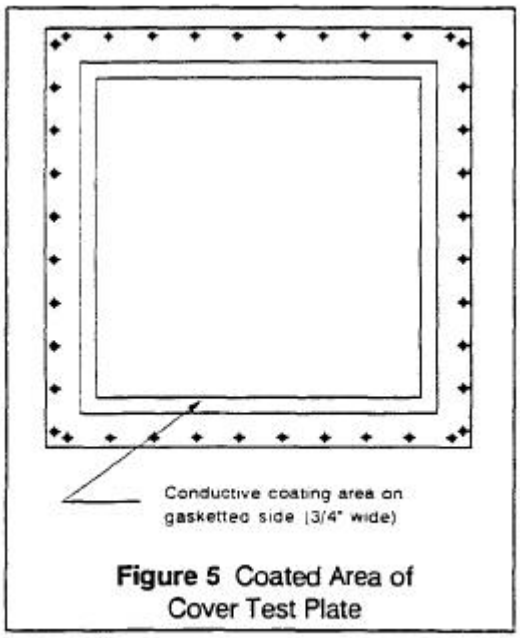

Figure 5 Coated Area of Cover Test Plate

4.3.2.2 The conductive coating is applied on the cover test plate (Figure 5) 1.21 inches (30.73 mm) from the outside edge (21.75 inch square [55.25cm]) in a 0.75 inch (1.91 cm) width around the test plate (20.25 inch square [51.44cm]), on the side to be mated with the test gasket.

4.3.2.3 The conductive coatings should be applied and cured in accordance with the manufacturer's specifications and recommendations.

4.3.2.4 Areas which are not designated for application of the conductive coating are to be coated with a non-conductive epoxy paint with appropriate primer, such that the conductive coating is overlapped by approximately. 1 inch (2.54 mm) by the non-conductive coating around both inside and outside edges.

4.3.2.5 The non-conductive coating that will be applied to the adapter test plate an cover test plate will overlap the conductive coating by.1 inch (2.54mm).

4.3.2.6 Care should be taken not to coat the area of the adapter test plate which mates with shielded enclosure.

5.0 SHIELDING EFFECTIVENESS MEASUREMENT

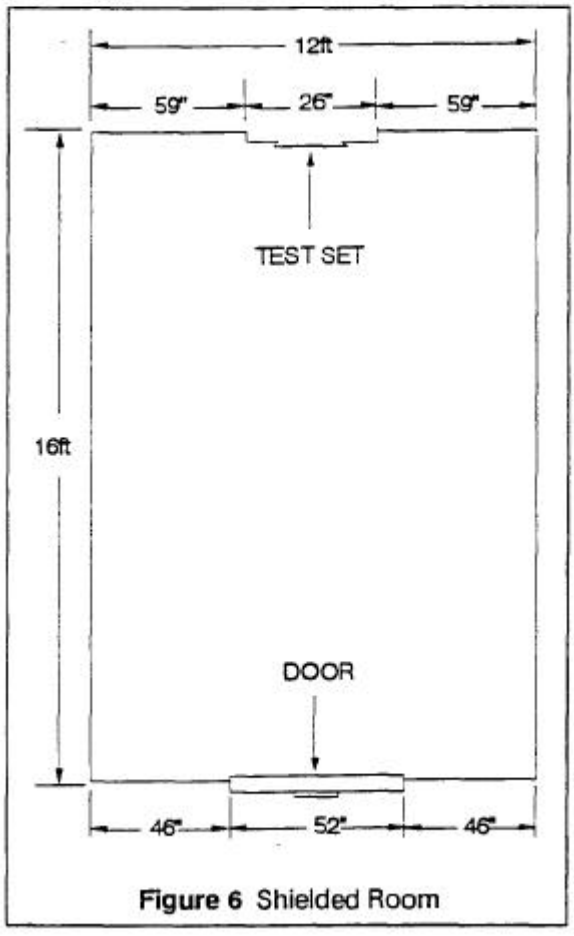

Figure 6 Shielded Room

5.1 The shielding effectiveness tests are based on MIL-STD-285 procedures, except as noted herein.

5.2 The EMI test chamber is 16 x 12 x 8 feet in size. See Figures 6 and 7 for further information on the shielded room. It was manufactured and installed by Sprague Corporation of North Adams, Massachusetts. Attenuation tests have demonstrated that the solid welded steel enclosure performs in excess of NSA 65-6 and MIL-STD-285 attenuation requirements. The transmitting antennas, RF amplifiers, and signal generators are placed outside the shielded room. The receiving antennas and the spectrum analyzers are placed inside the shielded room. The transmitting and receiving antenna distances shall be in accordance with MIL-STD-83528B (Note: MIL-STD-285 modification).

5.3 The test set (Figure 3) is mounted on the wall of the shielded room using BeCu fingerstock. The seam is then bridged with copper foil tape. The 1 /4 - 20 bolts used to connect the adapter plate to the shielded room flange are torqued to approximately 75 in-lbs without stripping.

5.4 Table 1 lists all of the equipment that can be used for this type of test.

5.5 Measurement Procedure

5.5.1 Test frequencies are as follows: 10MHz, 20MHz, 50MHz, 125MHz, 200MHz. 400MHz, 800MHz, 1 GHz, 2GHz, 3GHz, 4GHz, 6GHz, 8GHZ, 12GHz, 14GHz, and 18 GHz. The type of field (i.e., electric or plane wave), and the antenna polarization shall be kept constant during the test.

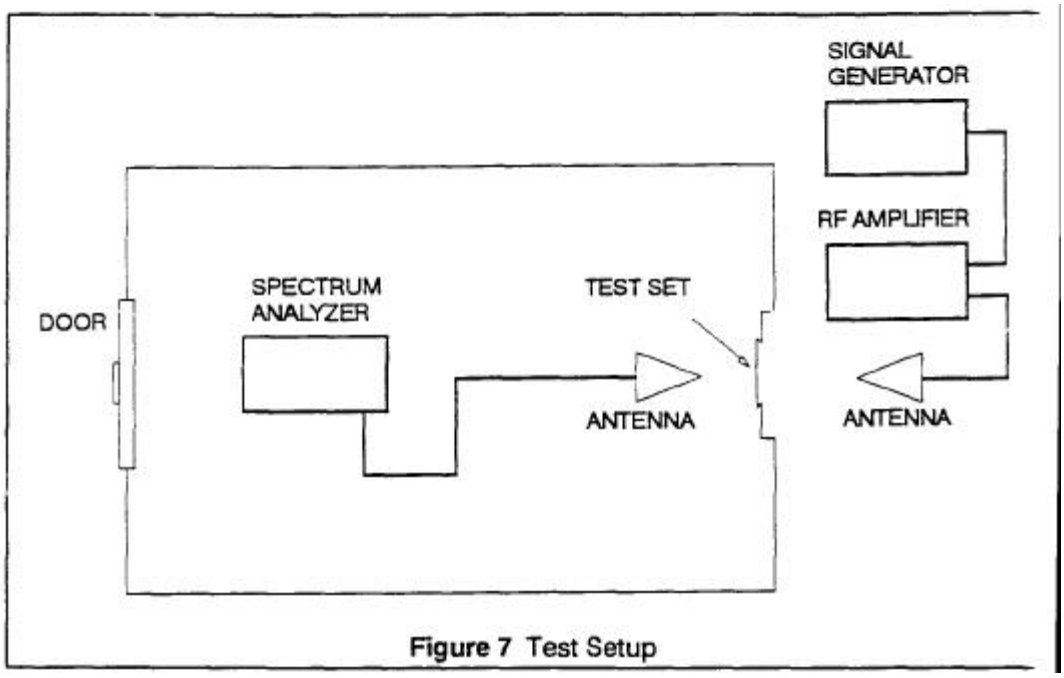

Figure 7 Test Setup

5.5.2 Due to the symmetrical nature of the test setup and fixtures, only one antenna polarization is required.

5.5.3 Open references shall be measured and recorded at each frequency in accordance with MIL-G-835288, with only the adapter plate (20″ x 20″ opening) attached to the wall of the shielded enclosure. The test setup is illustrated in Figure 7.

5.5.4 With the test set in place, signal levels should be measured and recorded at each frequency with the transmitting antenna outside the shielded room and the receiving antenna inside the shielded room at the identical distances used for the open reference measurements.

MANUFACTURER	MODEL #	DESCRIPTION
Hewlett Packard	8566B	Spectrum Analyzer
Hewlett Packard	85685A	RF Preselector
Tektronix	496	Spectrum Analyzer
Hewlett Packard	182T	Main Frame
Hewlett Packard	8558B	Spectrum Analyzer Plug-In
Hewlett Packard	8559A	Spectrum Analyzer Plug-In
Hewlett Packard	645A	Signal Generator
Hewlett Packard	8640B	Signal Generator
Hewlett Packard	8672A	Signal Generator
EMCO	3105	Horn Antenna
EMCO	3109	Bi-Con Antenna
EMCO	3107	Parallel Element Antenna
Singer	CLS-105A	Log Spiral Antenna
Chomerics	N/A	12 Guage, 12 Inch Magnetic Loop Antenna
ENI	603L	RF Amplifier
RF Power Labs	220-IK60L	RF Amplifier
Solar	6552-1A	Audio Amplifier
Logimetrics	A300L	TWT RF Amplifier
Logimetrics	300XU	TWT RF Amplifier
Logimetrics	A300 / S-08	TWT RF Amplifier
Logimetrics	300 / C-08	TWT RF Amplifier
Narda	768-20	Attenuator
Solar	N/A	Audio Transformer
AllTrade	N/A	Socket Torque Drive

Table 1 Test Equipment

5.5.5 Shielding effectiveness (SE) is determined by taking the power level recorded during any of the open reference measurement and subtracting the power level recorde with the test set and gasket in place. Below is a sampl calculation:

SE = Open Reference - Test Set Measurement

97Db = -10dBm - (-107dBm)

6.0 DC ELECTRICAL MEASUREMENT

6.1 DC measurements are useful in assessing electrical changes caused by environmental exposure and in generally predicting shielding effectiveness changes.

6.2 DC volume resistivity of conductive elastomer EMI gaskets should be made using the surface probe method of MIL-G-835288, Paragraph 4.6.11. The probe electrodes should be placed between the bolt clearance holes in the gasket. Calculate the volume resistivity of the gasket from

$$P = \frac{}{L}$$

Where p = DC volume resistivity (in ohm-cm)

R = measured resistance (in ohms)

A = gasket thickness (in cm)

L = distance between probe electrodes (2.54cm)

The measured resistance and calculated volume resistivity should be recorded at several points along the conductive elastomer.

6.3 Resistance measurements of the conductively coated aluminum panels may also t made using the MIL-G-835288 surface probe.

7.0 **ENVIRONMENTAL EXPOSURE**

7.1 The test sets should be removed from the wall of the shielded enclosure after the pre environmental exposure measurements and placed in the environmental chamber.

7.2 The test sets should be exposed for the required number of hours to appropriate environmental test conditions such as temperature/humidity cycling, salt spray, etc.). Test sets may be moved from the environmental chamber to the shielding test chamber in order to determine shielding effectiveness at intermediate points during the environmental exposure.

7.3 Suggested environmental test conditions include:
ASTM 8117 (MIL-STD-810E, Method 509.2) Method of salt spray (fog) testing
MIL-STD-202E Method 1038 and Method 106E Temperature/Humidity Cycling
ASTM G85, Annex 4 S02 Salt Fog testing

8.0 **POST-ENVIRONMENTAL EXPOSURE TESTING**

8.1 Remove the test set from the environmental chamber.

8.2 Do not open the test joint between the adapter plate and cover plate. The area of the adapter test plate which mates to the shielded room wall should be abraded clean.

8.3 Re-measure the shielding effectiveness as described in Section 5.0.

8.4 After the shielding effectiveness returned to the environmental chamber for additional exposure, or disassembled for DC electrical evaluations per Section 6.0

8.5 Examine the test plates and EMI gasket for any signs of corrosion or deterioration.

9.0 **TEST REPORT**

9.1 A list of all equipment used during the test and detailed test data sheets and/or plotted graph: are to be included in the test report. The test data sheets will include the test results, who performed the test, and where and when the test was performed. Refer to the Append, Document A for an example of the test data sheet.

9.2 Any deviation from the test plan shall be noted on the test data sheet and within the test report. A full explanation of the deviation will be

APPENDIX

CHOMERICS
Parker Seals

CHOMERICS RADIATION TEST SERVICE
SHIELDING EFFECTIVENESS TEST DATA

CHO-Contact

S.E.T. #

Date

Data Sheet #

Customer

Customer P/N

Product Tested

Quantity

Test Procedure

Requested By

Test Location

Antenna Polarization & Type of Field	Frequency	Open Reference	Closed	Shielding Effectiveness (dB)	Power (Watts)

Pre-Test Bolt Torque or Gasket Compressed Measurement Value:

Test By:

Approved By: