

Shielding Effectiveness Measurements on Various Conductive Elastomer Gaskets in Aluminum Flanges Subjected to SO₂ Salt Fog

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1 SUMMARY

This test was performed to measure shielding effectiveness of Chomerics and other manufacturers conductive gasket aluminum flange systems before and after SO₂ salt fog exposure. Radiated methods in accordance with MIL-STD-285.

Silicone and fluorosilicone elastomers filled with silver-plated aluminum, nickel fibers and nickel-coated graphite were tested. The smallest degradation in shielding effectiveness was exhibited by CHO-SEAL 1298 material. The nickel fiber and 80 wt% nickel-coated graphite filled materials exhibited the largest degradation in shielding effectiveness.

2 APPLICABLE DOCUMENTS

ASTM Standards

ASTM G85: Modified method of salt spray (fog) testing

Military Standards

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

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

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

MIL-STD 202: Test methods for electronic and electrical component parts
MIL-STD-45662: Calibration systems requirements

Additional Specifications

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

Chomerics CHO-TM200: Shielding Effectiveness Measurements of EMI Gaskets Subjected to Salt Fog Exposure (8.5" x 8.5' Aperture).

3 INTRODUCTION The purpose of this test was to measure the radiated electric field and plane wave attenuation levels of 6 test sets comprised of different EMI gasket materials before and after environmental exposure. The environmental exposure consisted of 192 hours of SO₂ Salt Fog.

This test effort was performed jointly by Chomerics' R&D department, Applications Lab and Radiation Test Services.

A separate report on the post-test material properties has been issued by Chomerics R&D department.

The tests were performed in accordance with Chomerics Test Method CHO-TM200 dated

August 1992, entitled "Shielding Effectiveness Measurements of EMI Gaskets Subjected to Salt Fog Exposure (8.5" x 8.5" Aperture)

4 TEST SETS, TEST PANEL, AND GASKET PREPARATION

Test Plates

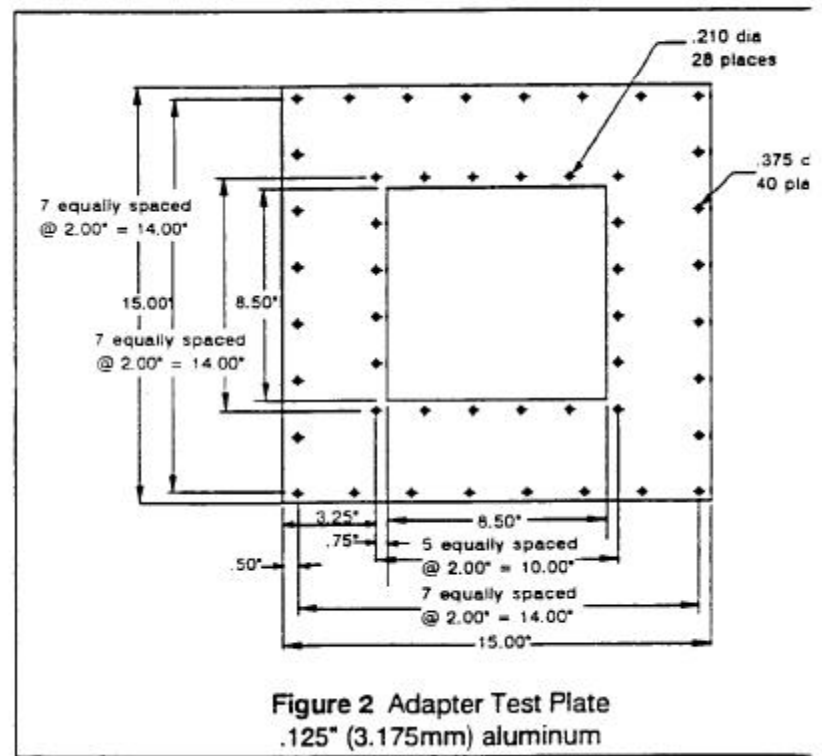
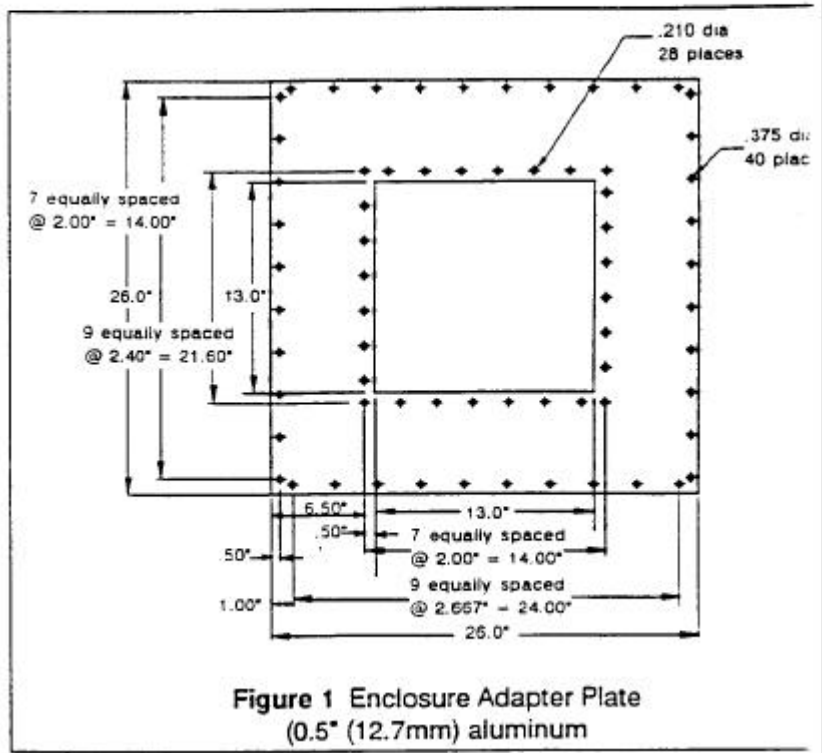
Three test plates were required to perform the tests. The three plates were as follows:

Enclosure Adapter Plate

The enclosure adapter plate, illustrated in Figure 1, matches the test aperture and bolt pattern on Chomerics' shielded enclosure (test chamber). The outer bolt pattern matches to the bolt pattern on the shielded enclosure wall. The inner bolt pattern matches to the plate 'sets' which make up the test samples. The enclosure adapter plate is .5 inch (12.7mm) thick T6061-T6 aluminum, and chromate conversion coated per MIL-C-5541 Class 3. Only one enclosure adapter plate was required.

Adapter Test Plate

The adapter test plate, illustrated in Figure 2, is one half of the test plate "set". The outer bolt pattern matches the inner bolt pattern on the enclosure adapter plate described above. The inner bolt pattern matches the bolt pattern on the cover test plate. The adapter test plate is .125 inch (3.175mm) thick T6061-T6

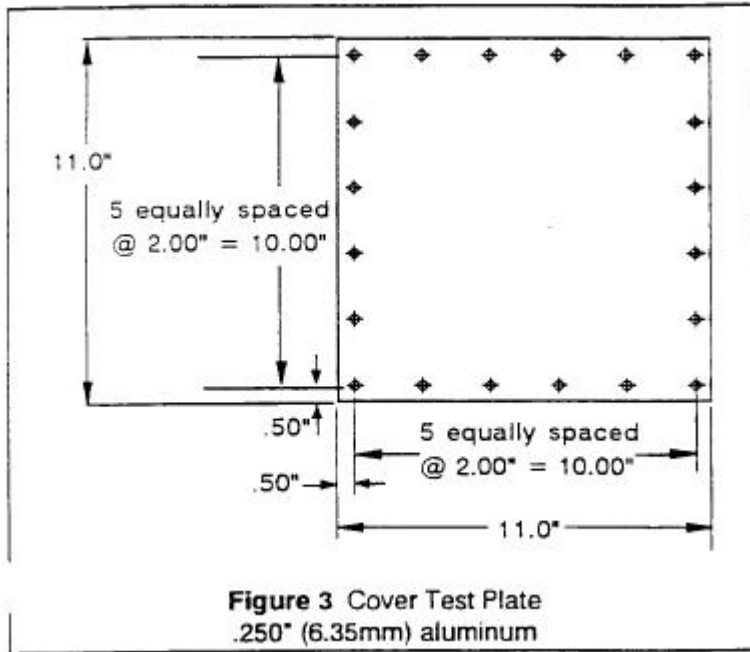


coated per MIL-C-5541 Class 3. Six adapter test plates were required.

Cover Test Plate

The cover test plate, illustrated in Figure 3 is the other half of the test plate "set". The bolt

pattern matches to the inner bolt pattern on the adapter test plate described above. The cover test plate is .250 inch (6.35mm) thick T6061-T6 aluminum, chromate conversion coated per MIL-C-5541 Class 3. Six cover test plates were required.



The test plates were sized so that the "set" (one adapter test plate and one cover test plate) could be placed within the SO₂ salt fog

test chamber. This allowed SO₂ salt fog exposure to be performed between two separate shielding effectiveness tests to determine the shielding degradation, if any, due to increasing durations of SO₂ salt fog exposure. In addition, this allowed the shielding tests to be performed without disassembling the test joints.

Multiple sets of test plates were prepared due to the number of gaskets evaluated.

Compression stops utilized were nonconductive plastic "shim" material, sized to assure 10% deflection of the .062 inch (1.57mm) thick gasket material (.056" [1.42mm] after deflection).

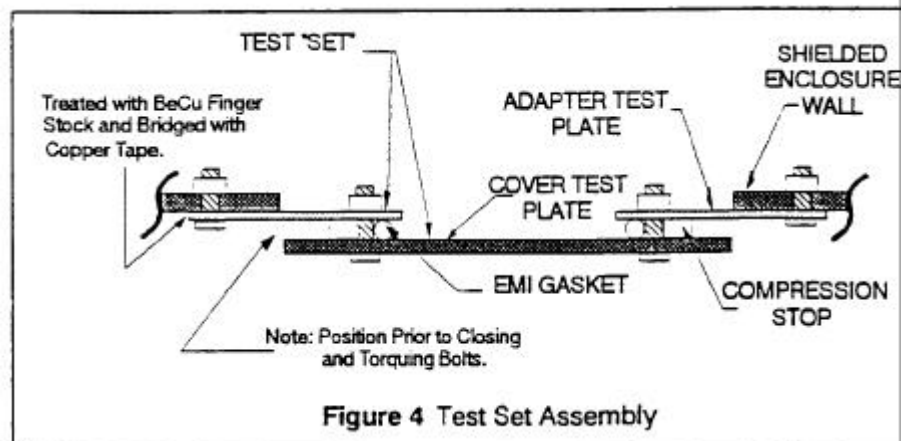
ELASTOMER	FILLER	BINDER
CHO-SEAL 1298	Ag plated Al	Fluorosilicone
Sample P	Nickel	Silicone
Sample J	Ag plated Al	Fluorosilicone
Sample S	Ag plated Al	Fluorosilicone
3558-76-1	60% Ni/Gr	Fluorosilicone
3558-76-2	80% Ni/Gr	Fluorosilicone

Table 1 Conductive Elastomers Tested

The complete test plate set assembly is illustrated in Figure 4.

Test Panel & Gasket Preparation

All of the test panels had a MIL-C-5541 Class 3



The gaskets are listed in Table 1.

Assembly of the test plate sets was accomplished after gasket fabrication. The

adapter test plate, cover test plate, gasket and compression stops were assembled using 10-24 bolts, as illustrated on Figure 4.

MANUFACTURER	MODEL	FREQUENCY
Hewlett Packard Signal Generator	8672A	2GHz - 18GHz
ENI Amplifier	600L	0.8MHz - 1020MHz
EMCO Biconical Antenna	3109	30MHz - 300MHz
EMCO Ridge Guide Antenna	3105	1GHz - 10GHz
Singer Log Spiral Antenna	CLS-105A	300MHz - 1GHz
Tektronix Analyzer	496	1kHz - 1.5GHz
Hewlett Packard Spectrum Analyzer	8559A	0.1GHz - 21GHz
Logimetrics Amplifier	A300/L	1GHz - 2GHz
Logimetrics Amplifier	A300/S-08	2GHZ - 4GHz
Logimetrics Amplifier	A300/C-08	4GHz - 8GHz
Logimetrics Amplifier	300/XU	8GHz - 18GHz

Table 2 Test Equipment Used

5 SHIELDING TESTS

The shielding tests were performed at Chomerics Inc., Woburn, Massachusetts, per the requirements of MIL-STD-285 as described within this document and within Chomerics Test Method, No. CHO-TM200.

Shielded Enclosure

The 12' x 8' x 16' shielded enclosure was manufactured by Sprague Shielding Corporation. Attenuation tests have demonstrated that the shielded enclosure meets the attenuation requirements of MIL-STD-285 and NSA 65-6. The enclosure is constructed of .250 inch (6.35mm) solid steel plate, continuously seam welded.

The available AC power within the shielded enclosure is 110V AC, 220V A single and three phase, 60 cycle. The power line filter are rated for 100dB c attenuation from 10kHz to 10GHz.

Mounting of Test Sets

The enclosure adapter plate and test sets were mounted on the wall of the shielded enclosure, with BeCu fingerstock material between the wall of the room and the adapter plate. The seam was additionally bridged with copper tape. The 1/4-20 bolts used to connect the adapter plate to the shielded enclosure wall were torqued to

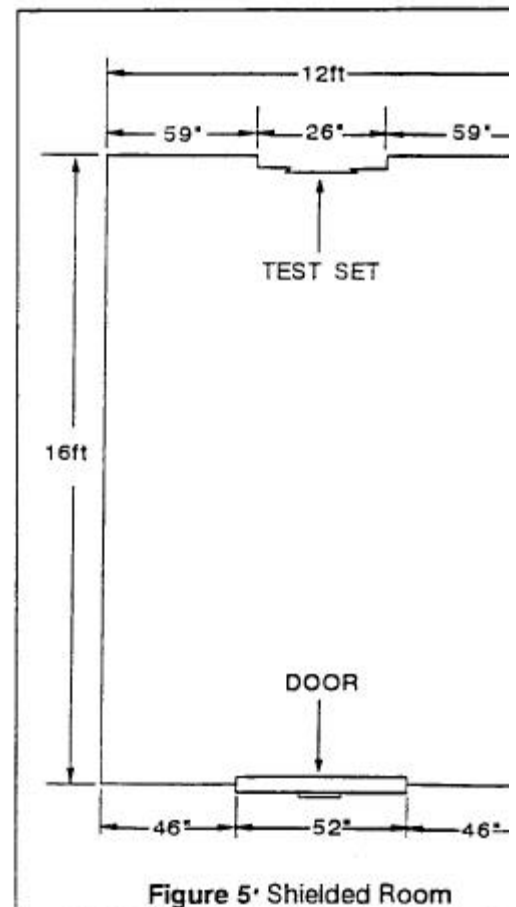


Figure 5' Shielded Room

approximately 75 in-lbs without stripping.

Test Equipment

Table 2 is a list of the of the equipment used to perform the radiated electric field and plane wave tests:

The equipment used to perform this test is calibrated per MILSTD-45662 at least once per year, and was in calibration at the time of the test.

6 MEASUREMENT PROCEDURES

This test was configured as defined within Chomerics'

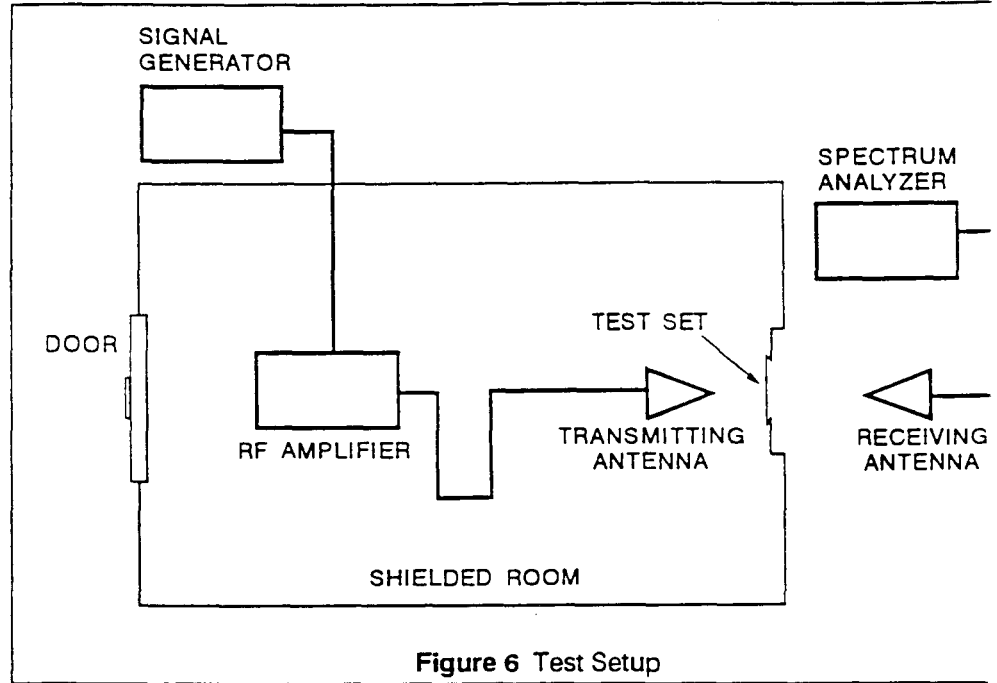
shielding effectiveness test method CHO-TM200. The transmitting antennas and the RF amplifiers were placed inside the shielded room. The receiving antennas, signal generators, and spectrum analyzers were placed outside the shielded enclosure. The spectrum analyzers and signal generator were placed 10 feet away from each other to achieve isolation between the transmit and receive test equipment.

The test was performed at frequencies of 2GHz, 3GHz, 4GHz, 5GHz, 6GHz, 7GHz, 8GHz, 9GHz and 10GHz.

Antenna orientation was vertical for all frequencies.

Figures 5 and 6 illustrate the shielded enclosure and test setup.

The transmitting and receiving antenna; were placed two feet apart plus the width of the test panel in accordance with MIL-STD-285. The



ELASTOMER	INITIAL VOLUME RESISTIVITY (OHM-CM)	FINAL VOLUM RESISTIVT (OHM-CM)
CHO-SEAL 1298	0.008	0.007 - 0.014
Sample P	0.011	0.021 - 0.357
Sample J	0.005	0.003 - 0.013
Sample S	0.006	0.005 - 0.025
3558-76-1	0.081	0.073 - 0.253
3558-76-2	0.033	0.085 - 0.372

Table 3 DC Volume Resistivity After SO₂ Salt Fog

open reference was taken in free space outside the shielded enclosure. The test measurement were taken with the transmitting antenna place inside the shielded enclosure and the receiving antenna placed outside the shielded enclosure

on opposite sides of the test panel. Both the transmitting and receiving antennas were placed one foot from the test panel.

Additional details of these measurement procedures and setup illustrations can be found in Chomerics Test Method No. CHO-TM200.

The shielding effectiveness (SE) was determined by taking the power level recorded during the open reference measurement and subtracting from the power level recorded with the test set in place. Below is a sample calculation:

$$\begin{aligned} \text{Open Reference} - \text{Test Measurement} &= \text{SE} \\ -10 \text{ dBm} - (-107 \text{ dBm}) &= 97 \text{ dB} \end{aligned}$$

DC volume resistivity of the EMI gaskets was made using the surface probe method of MIL-G-835286, Para 4.6.11. Measurements were taken before and after 192 hours of S02 salt fog exposure. The results are recorded in Table 3.

7 CONCLUSIONS

From the data taken during this evaluation, three conclusions can be drawn.

Chomerics' CHO-SEAL 1298 gasket demonstrated the best shielding effectiveness both before and after S0₂ salt fog exposure, and the least amount of degradation after salt fog exposure. Shielding effectiveness values were greater than 85dB, from 2GHz to 10GHz, even after S0₂ salt fog exposure. (Refer to Graph 1).

The nickel filled (sample P, Graph 2) and

nickel-coated graphite filled gaskets demonstrated the poorest shielding effectiveness and the most severe degradation after salt fog exposure. Shielding effectiveness values were 60-80dB from 2GHz to 10GHz after S0₂ salt fog exposure.

The silver-plated-aluminum filled fluorosilicone gaskets, sample J (Graph 3) and sample S (Graph 4) both degraded about 15 - 20dB after S0₂ salt fog exposure, with shielding effectiveness values of only 60-80dB after salt fog exposure.

Chomerics NB #3558-76-1, 60% Ni/Gr gasket material: shielding effectiveness test day after S0₂ environmental exposure indicated a reduction in shielding performance of approximately 18dB.

(Graph 5)

Chomerics NB #3558-76-2, 80% Ni/Gr gasket material: shielding effectiveness test data after S0₂ environmental exposure indicated a reduction in shielding performance approximately 30dB. (Refer to Graph 6)

