Parker Chomerics

TEST SERVICES

AN EVALUATION OF THE SHIELDING EFFECTIVENESS OF PARKER CHOMERICS CHO-SEAL EMI SHIELDING ELASTOMERS PER CHO-TP09

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IN ACCORDANCE WITH CHO-TP09

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1 General

1.1 Purpose

Conductive EMI gaskets are used to seal apertures in electronic enclosures against leakage of electromagnetic radiation. Metal-filled homogeneously conductive elastomers are one type of EMI gaskets used for this purpose. Conductive elastomers consist of small metal particles, typically in the range of 30 to 150 microns, dispersed within an elastomer binder system. Typical metal fillers include silver, silver plated materials (e.g., copper, glass, aluminum, nickel), nickel, nickel plated materials (e.g., aluminum, graphite and glass), and carbon. Examples of typical binders include silicone and fluorosilicone based resin systems.

The purpose of this document is to report the shielding effectiveness of Parker Chomerics Ni/Al and Ag/Al filled CHO-SEAL materials on chromate treated surfaces before and after environmental exposure per Chomerics Test Procedure CHO-TP09. Although this evaluation does not replicate the mechanical and/or electrical performance of a gasket in an actual electronic enclosure, it does allow for comparative evaluations between gasket materials using a standardized setup and test procedure.

The data obtained from these tests may or may not be equivalent to a gasket performance when installed in an actual enclosure (application). Variables such as metal surface treatment, gasket deflection, flange configuration, fastener spacing, as well as the source, amplitude, and frequency of electromagnetic fields all play a part in the shielding effectiveness of a gasket system installed in an electronic enclosure. Care should be taken in applying the absolute values obtained from these tests to other gasket/ flange geometries or enclosure designs.

All testing was performed by Chomerics Test Services of Woburn, Massachusetts over the period of four months from July 2009 to November 2009.

1.2 Administrative Information

1.2.1 Test Facility

The Parker Chomerics test facility operates under the current revision of Chomerics Test Services Quality Assurance (QA) Manual Document Number QA002.

The QA Manual has been constructed to reflect a quality program in accordance with the requirements of the National Institute of Standards and Technology (NIST), ISO 9002, ISO Guide 25, NIST Handbook 150, EN 45001, MIL-I-45208A, MIL-STD-461D, 462D and Chomerics Test Services Quality Assurance Program (QAP). The QA Manual outlines and describes the procedures for establishing and maintaining the quality of analysis, research, inspection, and testing within Chomerics Test Service (CTS).

This test report does not represent an endorsement by the U.S. Government.

The results and/or conclusions within this test report refer and/or apply only to the unit(s) tested as defined by this report.

Measurements performed for this test are traceable to the National Institute of Standards and Technology (NIST) based on the fact that all test equipment used for the measurements were previously calibrated using standards traceable to NIST.

The system amplitude accuracy for the measurements made during the radiated emission tests was ±3dB. Chomerics Test Services measurement uncertainty calculations are available for review upon request.

1.2.2 Equipment Calibration

The calibration of Chomerics test facility equipment is controlled under the current revision of Chomerics Laboratory Test Equipment Calibration Manual Document Number QA001.

The test equipment used throughout this test sequence conforms to laboratory calibration standards, ANSI/NCSL Z540-1, traceable to the National Institute of Standards and Technology (NIST). The date of the last calibration is listed in each test section for the applicable equipment.

We certify that the test equipment used to perform this test was in calibration at the time of the test and are calibrated per ANSI/NCSL Z540-1 at least once per year.

1.2.3 Test Personnel

The test personnel performing or supervising the tests are accredited by the National Association of Radio and Telecommunications Engineers, Inc. (NARTE) as Certified Electromagnetic Compatibility Engineers (N.C.E.) and Technicians (N.C.T.).

2 Test Set-Up

2.1 Test Site Description

All electric and plane wave shielding effectiveness measurements were performed at the Chomerics "Shielding Effectiveness" Test Chamber located in the Seeger Building at Parker Chomerics, 84 Dragon Court, Woburn, Massachusetts (see Figure 1). The shielded enclosure was manufactured by Sprague Shielding Corporation. Attenuation tests have demonstrated that the enclosure meets the attenuation requirements of IEEE-STD-299.

The receive chamber is a 0.250 inch thick plate steel structure measuring 12 by 16 by 8 feet in size. The structure is heated and/or air conditioned.

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

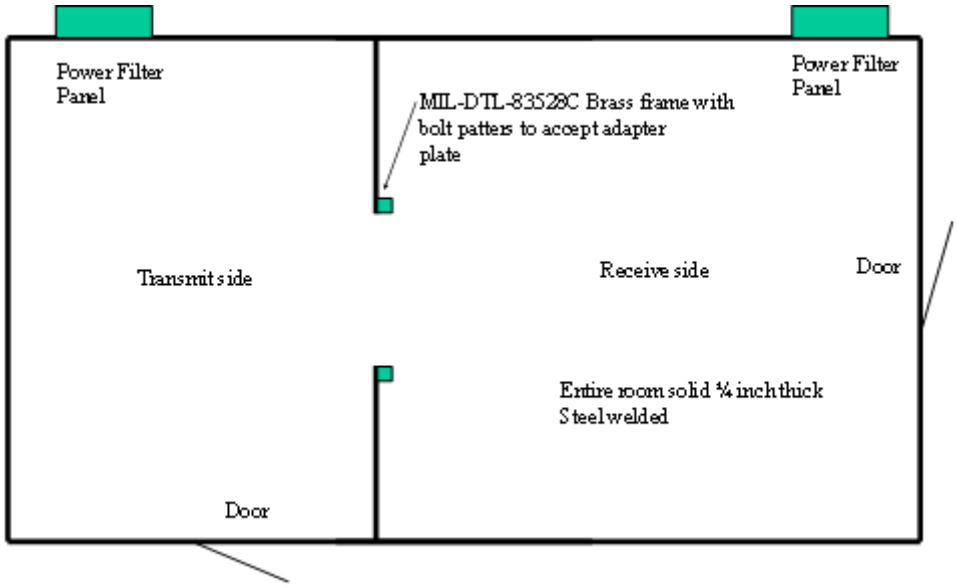


Figure 1 : Schematic of Chomerics "Shielding Effectiveness" Test Chamber

2.2 Test Plate Sets

The CHO-TP09 test plate sets used for this evaluation consist of two 6061-T6 aluminum plates manufactured to the specifications detailed in CHO-TP09. The first plate, referred to as the test frame is illustrated in Figure 2. The test frame is designed with a cutout in the center and two alternating bolt patterns. One pattern is used to bolt the test frame to the corresponding test cover plate (Figure 3) forming a test plate set. The second pattern accepts the hardware used to mount the fully assembled test plate set to the main adapter plate (Figure 4).

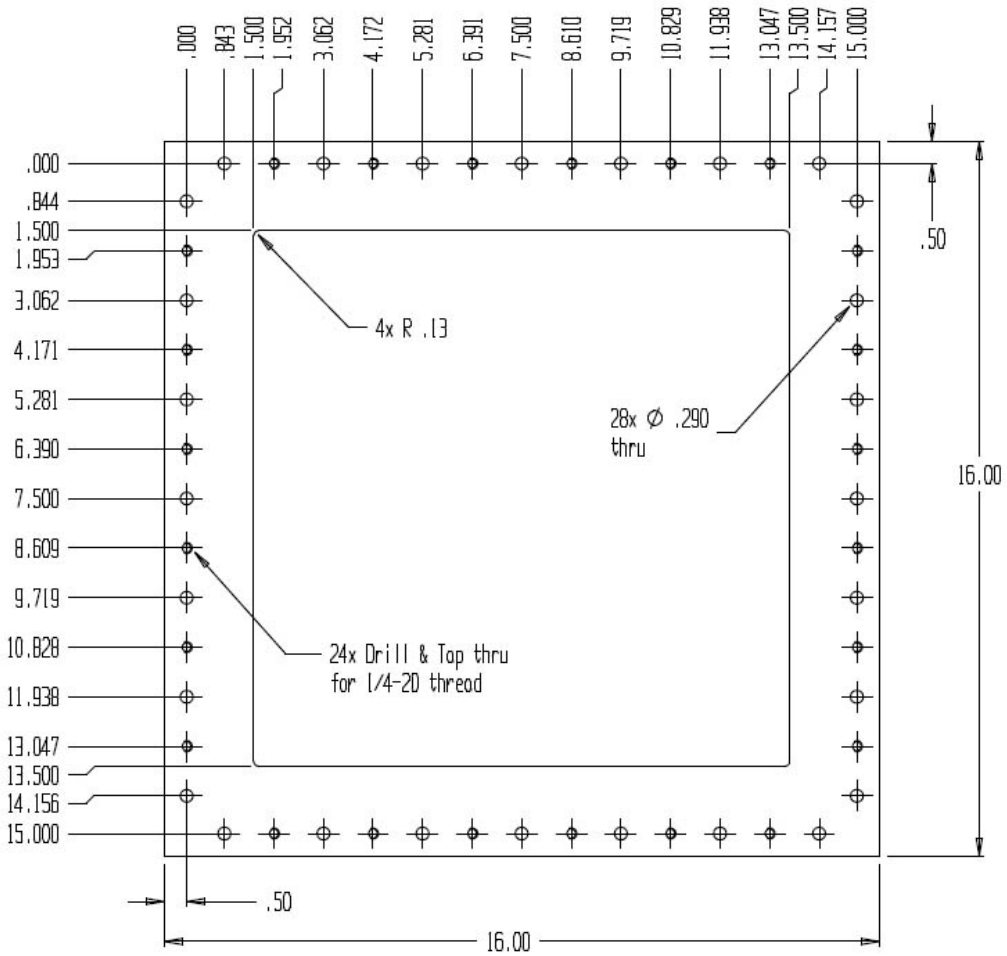


Figure 2 : CHO-TP09 Test Frame

The test cover plate (Figure 3) is also made from 6061-T6 aluminum and has the identical bolt hole configuration as the test frame described above.

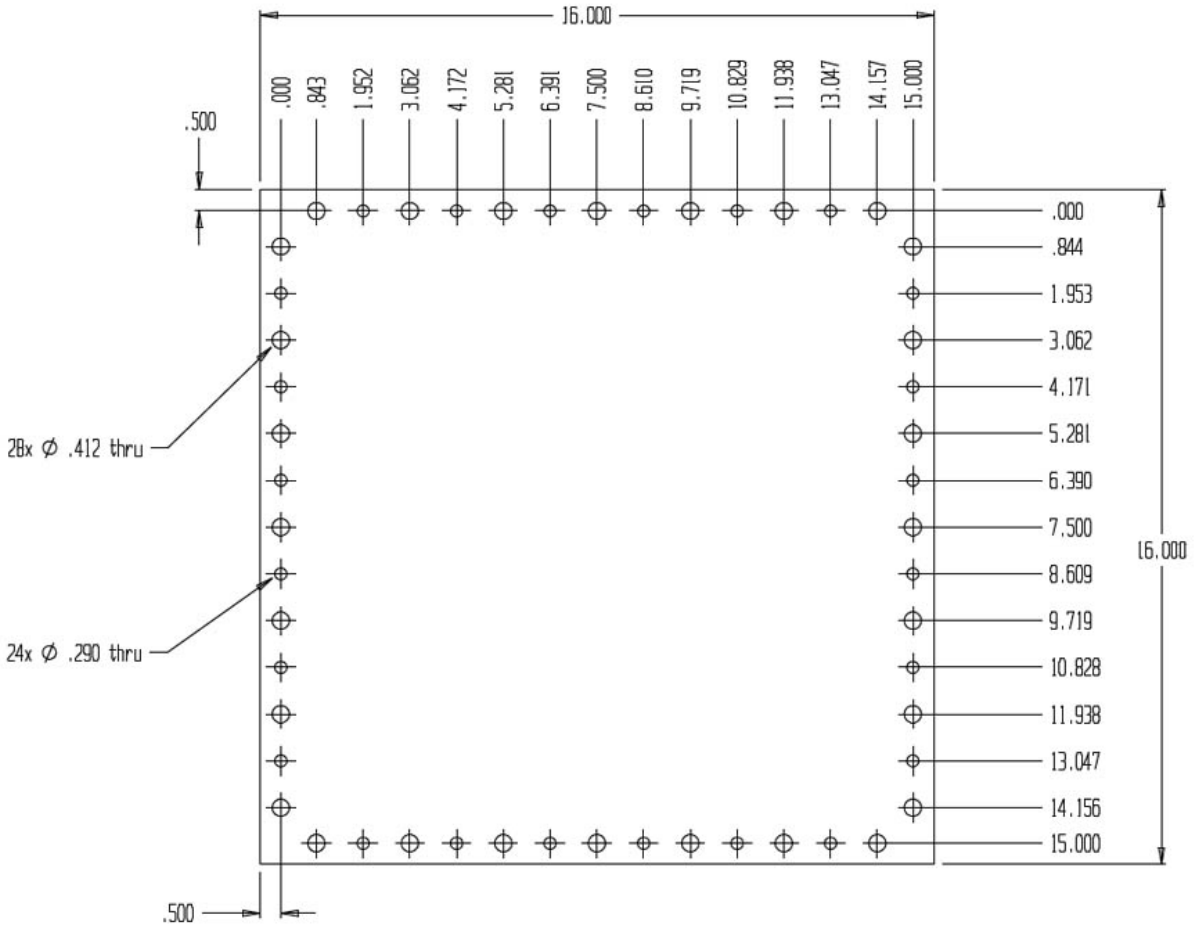


Figure 3 : CHO-TP09 Test Cover Plate

A 0.500 inch thick 6061-T6 aluminum main adapter plate illustrated in Figure 4 was used to mount the test plate sets to the shielded room wall. The outer bolt pattern detailed in Figures 4 was used to mate the adapter plate to the wall of the shielded room. The inner bolt pattern accepts the Test Plate set.

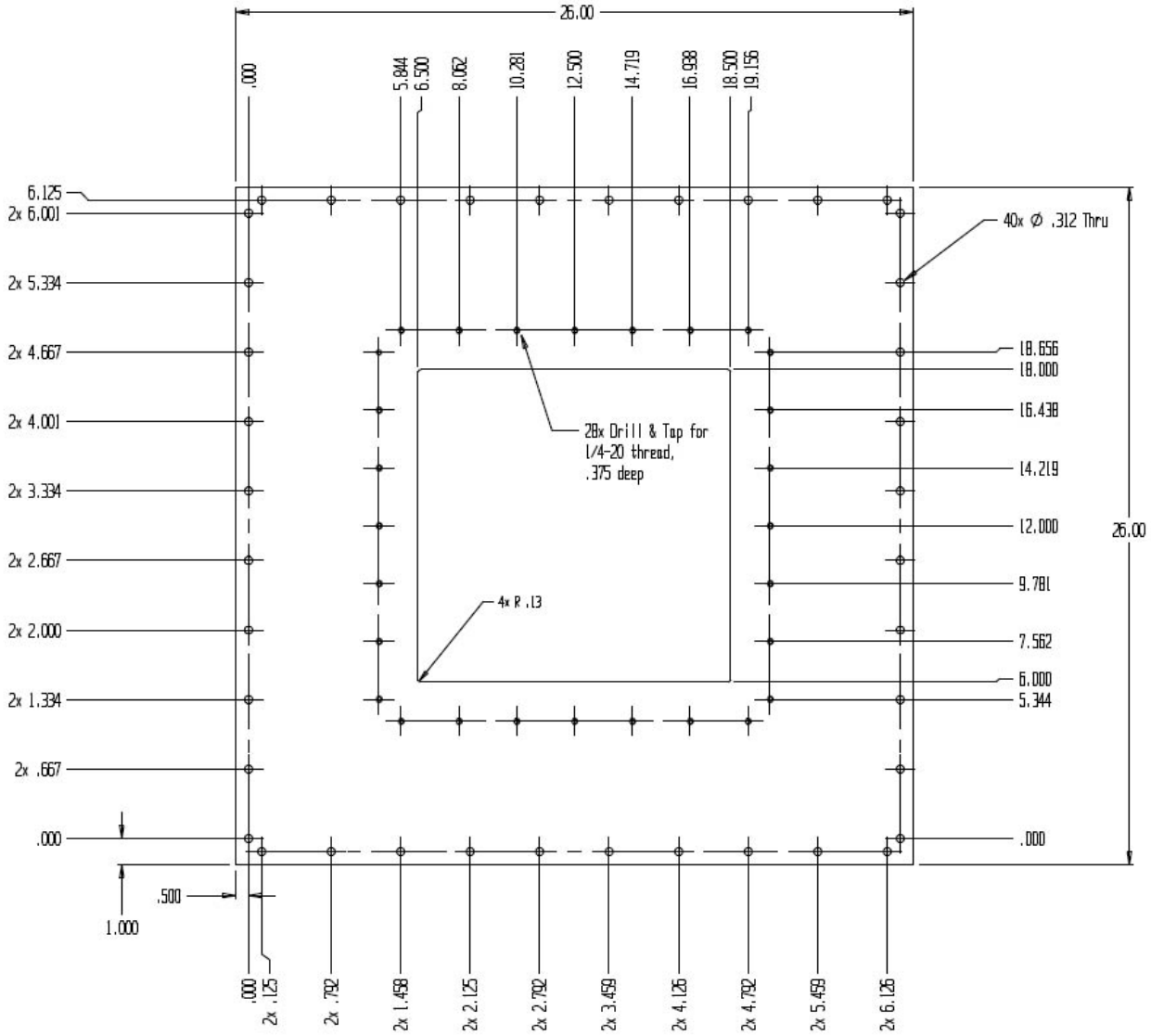


Figure 4 : Main Adapter Plate for Mounting Test Plate Sets to Wall of Shielded Enclosure

The following chromate conversion coating flange treatments were evaluated:

- MIL-C-5541, Class 3 Trivalent Chromate
- MIL-C-5541, Class 3 Hexavalent Chromate

2.3 Fixture Hardware

In addition to the test plates, non-conductive lexan shims were used as compression stops to target a nominal gasket deflection of 13.1%. The shims, illustrated in Figure 5, are designed to fit the bolt patter on the plate sets and prevent uneven deflection in regions adjacent to the bolts. Four shims were used per Test Plate set, one shim per side.

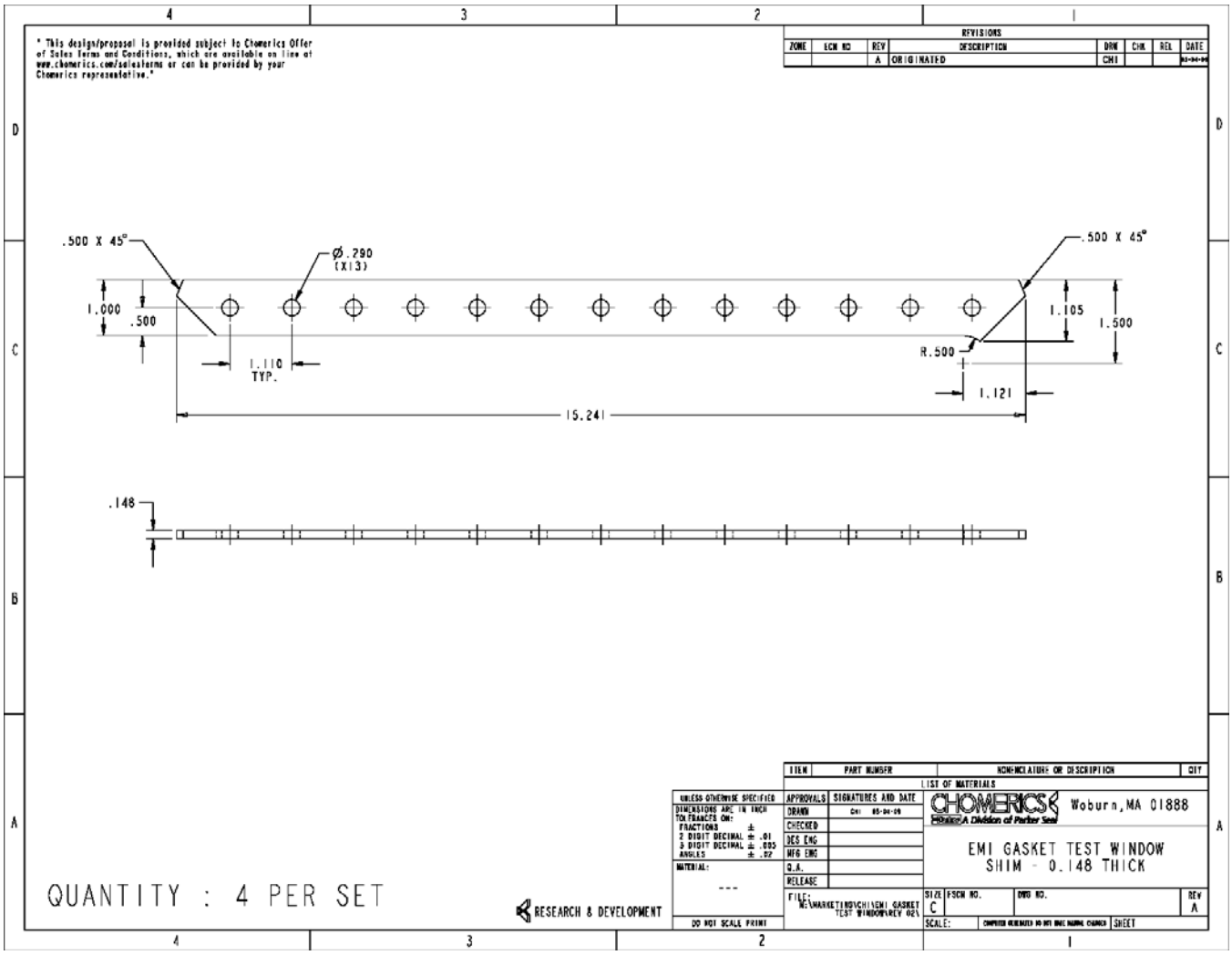


Figure 5 : Example of CHO-TP09 Gasket Test Window Shim

Black oxide alloy steel socket head cap screws were used to bolt the Test Plate Covers and Frames together and to bolt the plate sets to the shielded room wall.

2.4 Test Samples

The Cho-Seal gasket test samples were compounded and manufactured by trained operators per the approved manufacturing process instructions. The test sample profile consisted of a Solid "D" cross-section with nominal measurements of 0.175 inch in height by 0.178 inch in width as specified by CHO-TP09 (see Figure 6). For this evaluation, the Ni/Al filled elastomer is represented by the molded and extruded versions of CHO-SEAL 6502 and CHO-SEAL 6503, while the Ag/Al filled counterpart corresponds to the molded and extruded versions of CHO-SEAL 1298.

The Test Plate gasket configuration varied depending on the grade of the material. Extrusion grade elastomer gaskets consisted of a single part approximately 56.0 inches in length with the ends cut at complimentary 45 degree angles. Molding grade elastomer gaskets consisted of two 28.0 inch long parts with the ends cut at complimentary 45 degree angles.

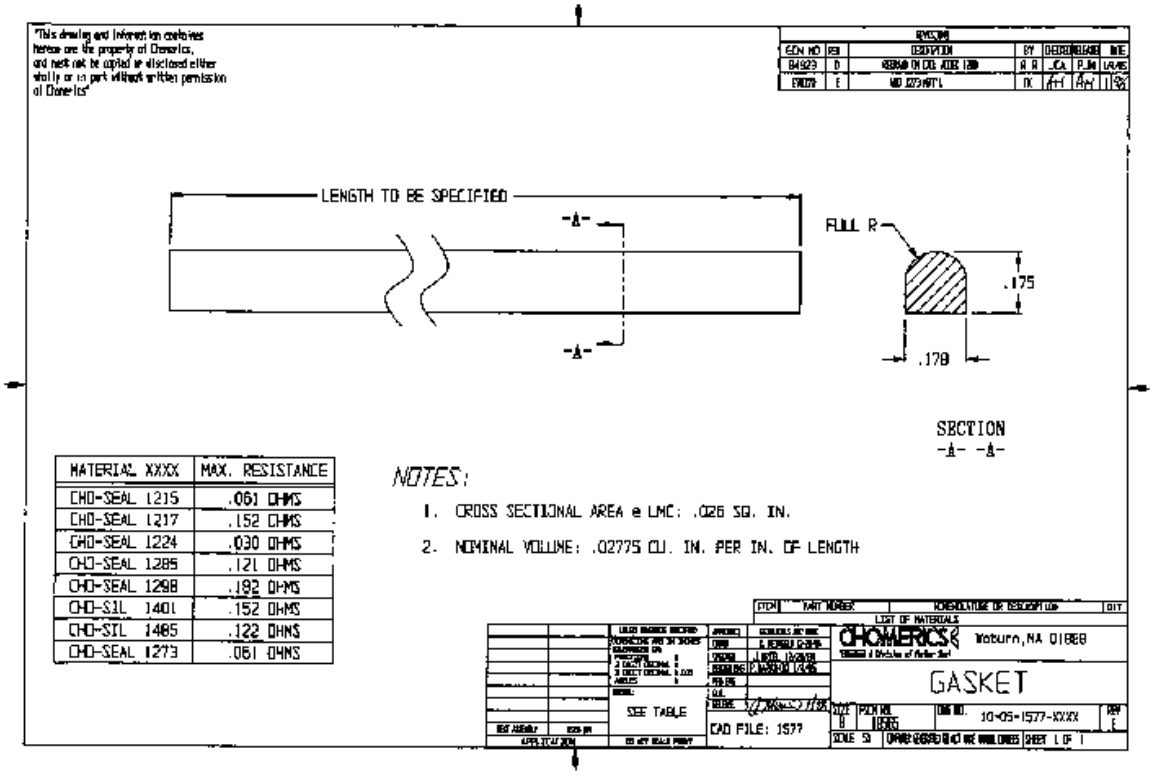


Figure 6 : Drawing of Solid "D" Profile

3 Test Plate Set Assembly

3.1 Equipment List

Table 1 : Equipment List for CHO-TP09 Test Fixture Assembly

Test Fixture Assembly Equipment	Asset #	Serial #	Calibration Schedule	Last Cal Date
Mitutoyo Model ID-C125TB Height Gage	N/A	801125	6 Months	Mar-09
Bosch Litheon - Compact Tough 18V Cordless Drill	N/A	N/A	N/A	N/A

Table 2 : CHO-TP09 Test Plate Set Hardware – One Complete Set

Hardware Description	QTY
CHO-TP09 Test Plate Frame	1
CHO-TP09 Test Plate Cover	1
CHO-TP09 Gasket Test Window Shims	4
0.25 inch diameter by 3.00 inch long set pins	8
0.75 Inch long, 1/4 – 20 thread black oxide alloy steel socket head cap screws	24

3.2 Assembly Procedure

Using a height gage, height measurements were taken at six inch intervals for every test sample. Based on the mean height of the sample population, the shim thickness was selected to achieve a nominal deflection of 13.1% when the Test Plate set was fully assembled. The selected shim thickness was also verified at the extreme minimum and maximum height measurements within the sample population to ensure that the deflection would be no less than 8.2% and no greater than 16.7% at any point along the gasket.

Prior to assembly, all surfaces of the Test Plate sets were wiped down with an isopropyl alcohol soaked rag and allowed to air dry for five minutes. Once dry, the test plate sets were assembled by laying the frame on a flat surface and installing the appropriate shims around the perimeter. The shims were temporarily held in place by set pins placed at each end of the shim through a bolt hole used to mate the assembled test plate to the wall of the shielded enclosure. With the shims in place, the gasket was installed with the flat side seated on the surface of the frame. The gasket configuration was a square “picture frame” with outside dimensions adequate to fit inside the bolt pattern of the cover plate while maintaining separation from the compression stops (shims). Regardless of material grade (molded and extruded), the gaskets were assembled by butting

the complimentary 45 degree ends of the parts together producing in a square “picture frame” gasket held firmly in place by the force of friction. An example of a CHO-TP09 Test Plate set mid-assembly can be found in Figure 7 below.

The test plate cover was then screwed to the test plate frame using 24 socket head cap screws referenced in Section 2.3 above. The screws were tightened as much as possible to the compression stop without stripping, stretching or breaking. The set pins were then removed and the fixture was ready for testing.

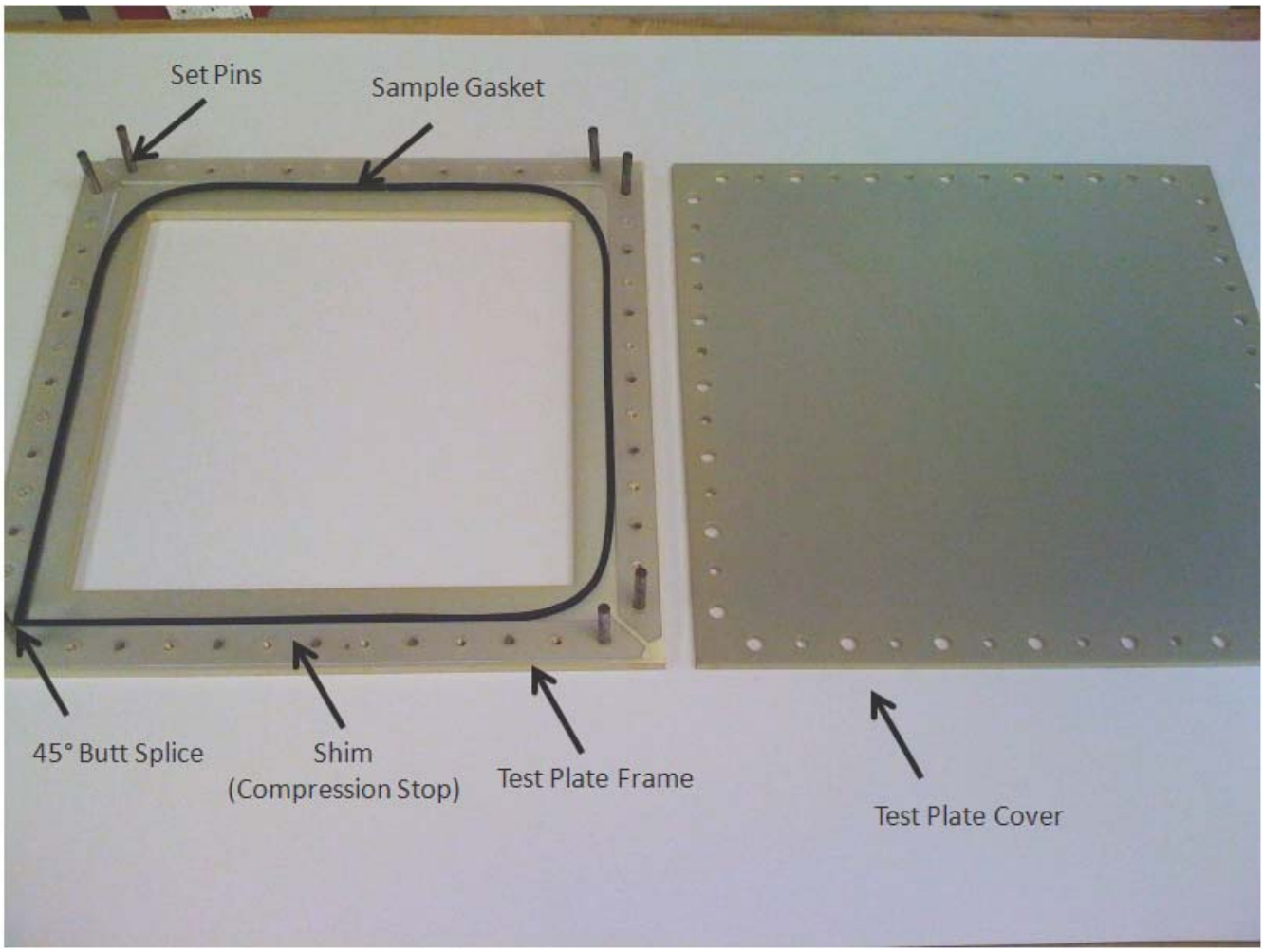


Figure 7 : Example of CHO-TP09 Test Plate Set

4 Environmental Exposure

4.1 Equipment List

Table 3 : Environmental Aging Equipment

Environmental Aging Equipment	Asset #	Serial #	Calibration Schedule	Last Cal Date
Humidity Chamber: CSZ ZH-8-1-H/AC	N/A	Z0043465	12 Months	Mar-09
Dry Heat Oven: Blue M D-3992-Q	N/A	18A322	12 Months	Aug-09
Salt Fog Chamber: Singleton Corp. Model 20	N/A	23383	N/A	N/A

4.2 Exposure Conditions

Table 4 : Environmental Aging Exposure Conditions

Environmental Exposure	Dwell Conditions	Dwell Duration
Static Dry Heat	125°C +/- 1°C	2,000 Hours
Static Heat and Humidity	85°C +/- 1°C and 85% RH +/- 5% RH	1,000 Hours
Neutral (ASTM B117) Salt Fog	Neutral (ASTM B117) Salt Fog (35°C +/- 1°C)	500 Hours

4.3 Overview of Test Plate Sets: Flange Treatments and Exposure Conditions

Table 5 : Summary of Test Plate Set Flange Treatments Evaluated per Environmental Exposure

	MIL-C-5541, Class 3	
	Trivalent Chromate	Hexavalent Chromate
Static Dry Heat	4	4
Static Heat and Humidity	4	4
Neutral (ASTM B117) Salt Fog	4	4

5 Tests Performed - Electric and Plane Wave Shielding Effectiveness (SE)

5.1 Equipment List

Table 6 : Electric and Plane Wave Shielding Effectiveness Test Equipment

Test Equipment	Asset #	Serial #	Calibration Schedule	Last Cal Date
HP 8341B Signal Generator	105	2650A00418	12 Months	Jan - 09
A.R. 150L Amplifier	888	9747	N/A	NCR
A.R. 30W1000M7 Amplifier	480	15657	N/A	NCR
Logimetrics A300/S-08 Amplifier	133	3016	N/A	NCR
Logimetrics A300/C-08 Amplifier	132	3012	N/A	NCR
Logimetrics A300/IJ Amplifier	134	3094	N/A	NCR
Agilent 4440A Spectrum Analyzer	704	US41421236	12 Months	Feb - 09
EMCO 3109 Biconical Antenna	87	2123	12 Months	Jan - 09
EMCO 3109 Biconical Antenna	82	2054	12 Months	Jan - 09
Singer CLS-105 Log Spiral Antenna	83	00315-5007	N/A	NCR
Singer CLS-105 Log Spiral Antenna	89	00316-4780	N/A	NCR
EMCO 3115 Double Ridge Guide Antenna	375	2345	N/A	NCR
EMCO 3115 Double Ridge Guide Antenna	376	2175	12 Months	Jan - 09

5.2 Test Method

Parker Chomerics Test Method CHO-TP09, The Test Method to Measure the Shielding Effectiveness Performance of EMI Gaskets, was used to evaluate the Shielding Effectiveness of CHO-SEAL gasket materials before and after exposure to accelerated environmental aging.

As outlined in CHO-TP09 and Figures 8 and 9 below, all transmit equipment, including the amplifier, signal generator and antenna was positioned on one side of the shielded enclosure while the detection system and receive antenna were located in the opposite shielded side. The transmit and receive antennas were placed on opposite sides of the test fixture at a distance of 1 meter from the aperture.

E-Field/Plane wave tests were performed at frequencies of 30MHz, 40MHz, 60MHz, 80MHz, 100MHz, 200MHz, 400MHz, 600MHz, 800MHz, 1GHz, 2GHz, 4GHz, 6GHz, 8GHz, 10GHz. 12GHz, 14GHz, 16GHz and 18GHz.

One test plate set was evaluated at a time by first taking the open reference signal measurements at the frequencies detailed above. The open reference signal measurement was performed by transmitting through the 12 inch by 12 inch square opening, with the antennas located in the same position as the final testing, but with no cover plate or plate set over the open aperture. This "through hole" reference measurement technique was performed in accordance with the requirements of MIL-DTL-83528C (see Figure 8).

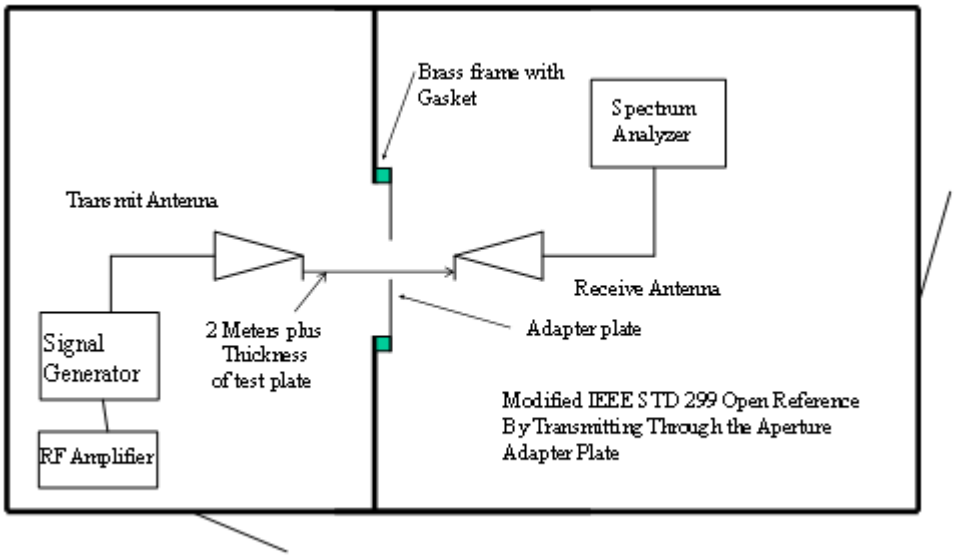


Figure 8 : CHO-TP09 Shielding Effectiveness Open Reference Test Set-Up

Once the open reference measurements were performed, the fully assembled test plate set was then attached to the main adapter plate bolted to the wall of the shielded room. Final signal measurements were performed on the un-aged test plate sets at the same frequencies used for the open reference signal measurements. The final measurement test set-up is detailed in Figure 9. An expanded cross-sectional view is detailed in Figure 10.

Once the final signal measurements were performed, the test plate sets were subjected to one of the three environmental exposure conditions listed in Table 4.

Following environmental exposure, the aged test sets were allowed to re-acclimate to ambient conditions for a minimum of 10 hours prior to re-testing. The flange area where the test plate set mates to the shielded

enclosure was gently wiped with a coarse pad to help ensure the flange was clean and dry to optimize the electrical connection to the shielded enclosure. Open reference and final signal measurements were then repeated for each aged test plate set.

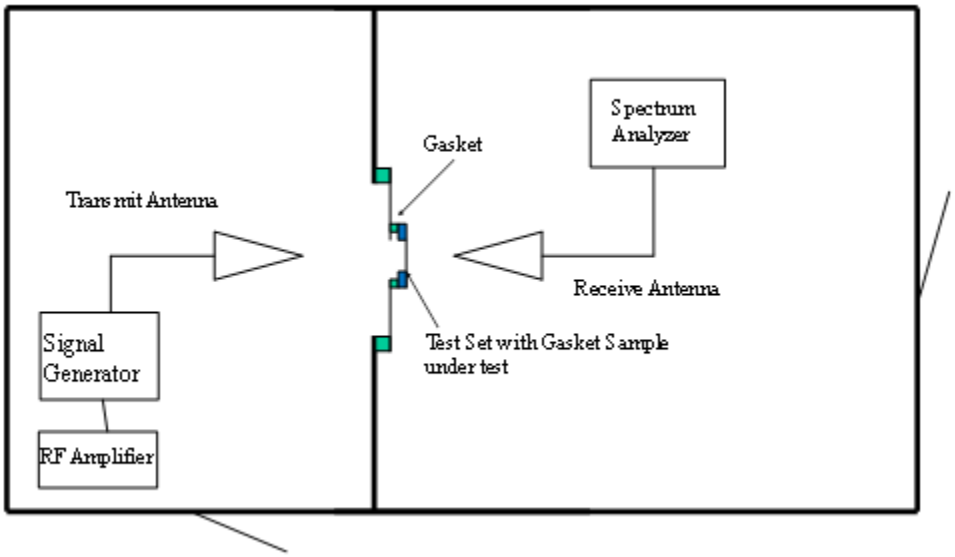


Figure 9 : CHO-TP09 Shielding Effectiveness Final Measurement Test Set-Up

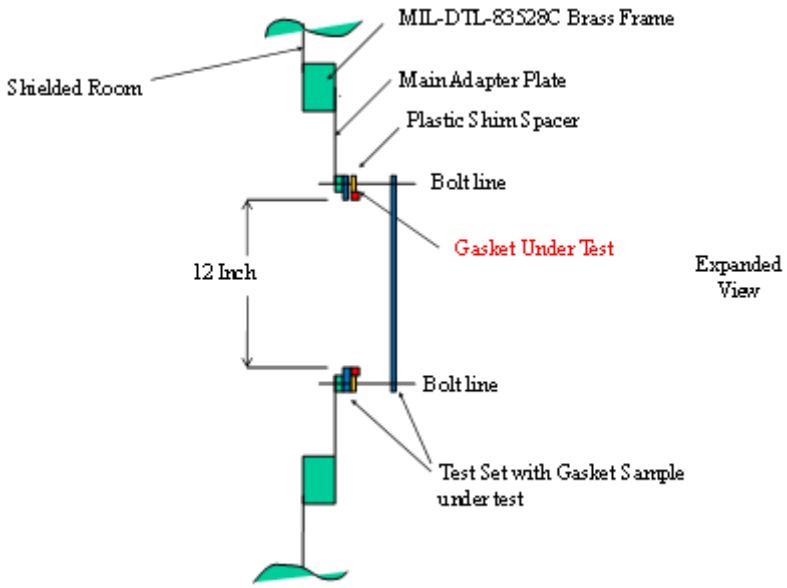


Figure 10 : Expanded Cross Sectional View of CHO-TP09 Test Plate Set-Up

5.3 Experimental Results

Data Sheet 1 : Ni/Al CHO-SEAL - Initial Baseline SE

SHIELDING EFFECTIVENESS TEST DATA

Customer:	Parker Chomerics R&D	**Date:**	11/17/2009
Product Tested:	Ni/Al CHO-SEAL	**Test No.:**	1
Tested by:	Bill Couture	**Test Spec.:**	TP-09
R&D Reference:	Initial Baseline Data		

Type of Field	Frequency MHz	Antenna Polarization	Open Reference	Closed	Shielding Effectiveness (dB)	Limits:	Open Reference
E	30	H	-37	-121	84	N/A	Thru Opening
E	40	H	-27	-111	84	N/A	Thru Opening
E	60	H	-10	-100	90	N/A	Thru Opening
E	80	H	-2	-93	91	N/A	Thru Opening
E	100	H	-8	-105	97	N/A	Thru Opening
E	200	H	11	-91	102	N/A	Thru Opening
E	400	C	21	-100	121	N/A	Thru Opening
E	600	C	18	-103	121	N/A	Thru Opening
E	800	C	13	-107	120	N/A	Thru Opening
E	1,000	C	12	-107	119	N/A	Thru Opening
P	2,000	V	-17	-132	115	N/A	Thru Opening
P	4,000	V	8	-106	114	N/A	Thru Opening
P	6,000	V	7	-109	116	N/A	Thru Opening
P	8,000	V	-5	-124	119	N/A	Thru Opening
P	10,000	V	3	-112	115	N/A	Thru Opening
P	12,000	V	-3	-115	112	N/A	Thru Opening
P	14,000	V	-2	-113	111	N/A	Thru Opening
P	16,000	V	-3	-108	105	N/A	Thru Opening
P	18,000	V	-23	-128	105	N/A	Thru Opening

Comments:

1) Data averaged from four test samples
2) Test data taken over four month period
3) System noise floor is -135dBm

Data Sheet 2 : Ni/Al CHO-SEAL - SE After 2,000 Hours @ 125°C Dry Heat

SHIELDING EFFECTIVENESS TEST DATA

Customer:	Parker Chomerics R&D	**Date:**	11/17/2009
Product Tested:	Ni/Al CHO-SEAL	**Test No.:**	2
Tested by:	Bill Couture	**Test Spec.:**	TP-09
R&D Reference:	After 2,000 Hours @ 125°C Dry Heat		

Type of Field	Frequency MHz	Antenna Polarization	Open Reference	Closed	Shielding Effectiveness (dB)	Limits:	Open Reference
E	30	H	-37	-121	84	N/A	Thru Opening
E	40	H	-27	-112	85	N/A	Thru Opening
E	60	H	-10	-101	91	N/A	Thru Opening
E	80	H	-2	-93	91	N/A	Thru Opening
E	100	H	-8	-106	98	N/A	Thru Opening
E	200	H	11	-91	102	N/A	Thru Opening
E	400	C	21	-98	119	N/A	Thru Opening
E	600	C	18	-103	121	N/A	Thru Opening
E	800	C	13	-106	119	N/A	Thru Opening
E	1,000	C	12	-107	119	N/A	Thru Opening
P	2,000	V	-17	-131	114	N/A	Thru Opening
P	4,000	V	8	-103	111	N/A	Thru Opening
P	6,000	V	7	-104	111	N/A	Thru Opening
P	8,000	V	-5	-123	118	N/A	Thru Opening
P	10,000	V	3	-113	116	N/A	Thru Opening
P	12,000	V	-3	-117	114	N/A	Thru Opening
P	14,000	V	-2	-114	112	N/A	Thru Opening
P	16,000	V	-3	-108	105	N/A	Thru Opening
P	18,000	V	-23	-128	105	N/A	Thru Opening

Comments:

1) Data averaged from four test samples
2) Test data taken over four month period
3) System noise floor is -135dBm

Data Sheet 3 : Ni/Al CHO-SEAL - SE After 1,000 Hours @ 85°C & 85%RH

SHIELDING EFFECTIVENESS TEST DATA

Customer:	Parker Chomerics R&D	**Date:**	11/17/2009
Product Tested:	Ni/Al CHO-SEAL	**Test No.:**	3
Tested by:	Bill Couture	**Test Spec.:**	TP-09
R&D Reference:	After 1,000 Hours @ 85°C & 85% RH		

Type of Field	Frequency MHz	Antenna Polarization	Open Reference	Closed	Shielding Effectiveness (dB)	Limits:	Open Reference
E	30	H	-37	-114	77	N/A	Thru Opening
E	40	H	-27	-106	79	N/A	Thru Opening
E	60	H	-10	-94	84	N/A	Thru Opening
E	80	H	-2	-87	85	N/A	Thru Opening
E	100	H	-8	-99	91	N/A	Thru Opening
E	200	H	11	-91	102	N/A	Thru Opening
E	400	C	21	-96	117	N/A	Thru Opening
E	600	C	18	-95	113	N/A	Thru Opening
E	800	C	13	-92	105	N/A	Thru Opening
E	1,000	C	12	-96	108	N/A	Thru Opening
P	2,000	V	-17	-120	103	N/A	Thru Opening
P	4,000	V	8	-101	109	N/A	Thru Opening
P	6,000	V	7	-99	106	N/A	Thru Opening
P	8,000	V	-5	-107	102	N/A	Thru Opening
P	10,000	V	3	-98	101	N/A	Thru Opening
P	12,000	V	-3	-105	102	N/A	Thru Opening
P	14,000	V	-2	-95	93	N/A	Thru Opening
P	16,000	V	-3	-94	91	N/A	Thru Opening
P	18,000	V	-23	-114	91	N/A	Thru Opening

Comments:

1) Data averaged from four test samples
2) Test data taken over four month period
3) System noise floor is -135dBm

Data Sheet 4 : Ni/Al CHO-SEAL - SE After 500 Hrs Neutral (ASTM B117) Salt Fog

SHIELDING EFFECTIVENESS TEST DATA

Customer:	Parker Chomerics R&D	**Date:**	11/17/2009
Product Tested:	Ni/Al CHO-SEAL	**Test No.:**	4
Tested by:	Bill Couture	**Test Spec.:**	TP-09
R&D Reference:	After 500 hrs Salt Fog		

Type of Field	Frequency MHz	Antenna Polarization	Open Reference	Closed	Shielding Effectiveness (dB)	Limits:	Open Reference
E	30	H	-37	-104	67	N/A	Thru Opening
E	40	H	-27	-94	67	N/A	Thru Opening
E	60	H	-10	-81	71	N/A	Thru Opening
E	80	H	-2	-77	75	N/A	Thru Opening
E	100	H	-8	-86	78	N/A	Thru Opening
E	200	H	11	-76	87	N/A	Thru Opening
E	400	C	21	-78	99	N/A	Thru Opening
E	600	C	18	-76	94	N/A	Thru Opening
E	800	C	13	-72	85	N/A	Thru Opening
E	1,000	C	12	-74	86	N/A	Thru Opening
P	2,000	V	-17	-94	77	N/A	Thru Opening
P	4,000	V	8	-80	88	N/A	Thru Opening
P	6,000	V	7	-79	86	N/A	Thru Opening
P	8,000	V	-5	-86	81	N/A	Thru Opening
P	10,000	V	3	-85	88	N/A	Thru Opening
P	12,000	V	-3	-85	82	N/A	Thru Opening
P	14,000	V	-2	-88	86	N/A	Thru Opening
P	16,000	V	-3	-94	91	N/A	Thru Opening
P	18,000	V	-23	-114	91	N/A	Thru Opening

Comments:

1) Data averaged from four test samples
2) Test data taken over four month period
3) System noise floor is -135dBm

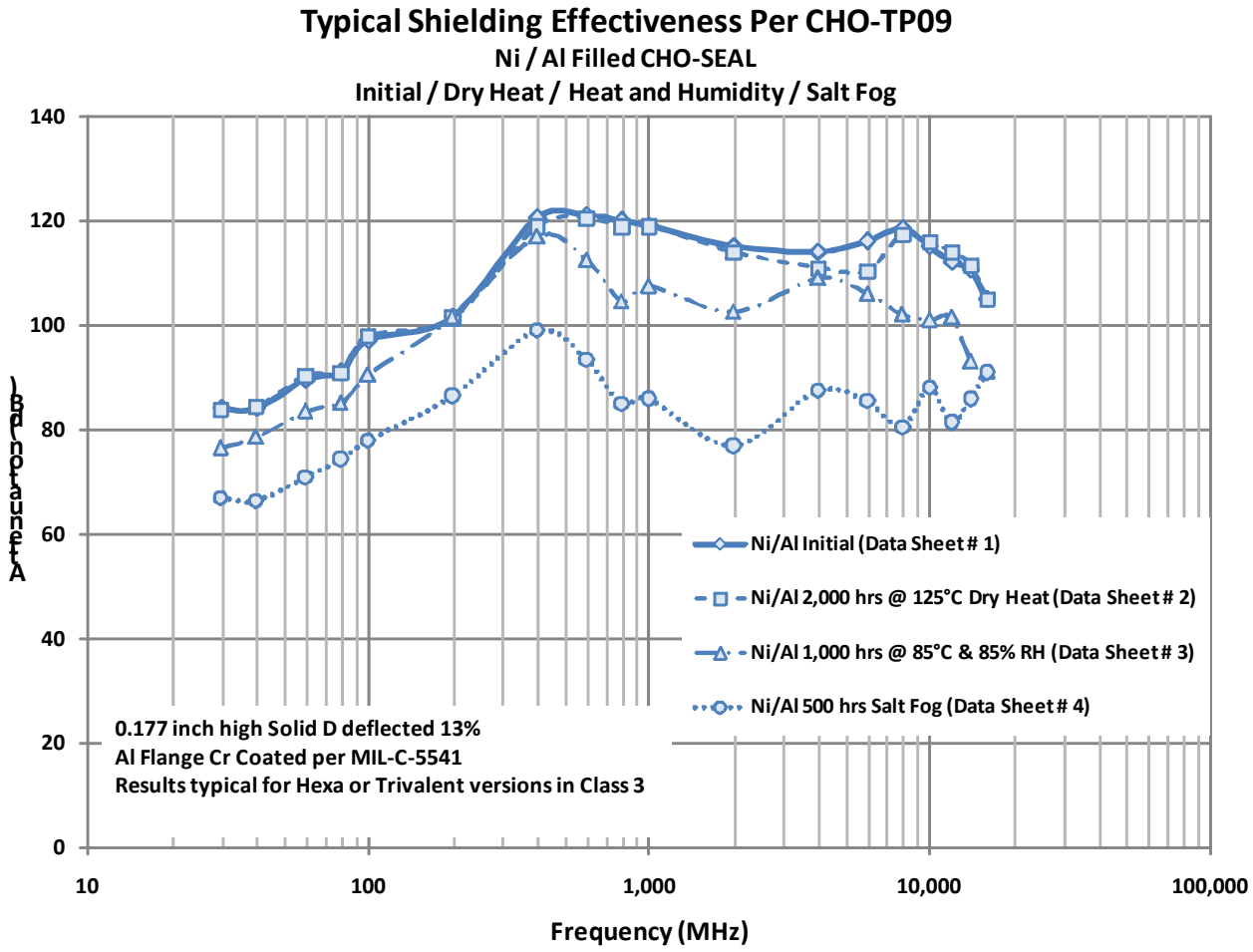


Figure 11 : Shielding Effectiveness: Ni/Al CHO-SEAL - Initial / Dry Heat / Humidity / Salt Fog

Data Sheet 5 : Ag/Al CHO-SEAL - Initial Baseline SE

SHIELDING EFFECTIVENESS TEST DATA

Customer:	Parker Chomerics R&D	**Date:**	11/17/2009
Product Tested:	Ag/Al CHO-SEAL	**Test No.:**	5
Tested by:	Bill Couture	**Test Spec.:**	TP-09
R&D Reference:	Initial Baseline Data		

Type of Field	Frequency MHz	Antenna Polarization	Open Reference	Closed	Shielding Effectiveness (dB)	Limits:	Open Reference
E	30	H	-37	-112	75	N/A	Thru Opening
E	40	H	-27	-105	78	N/A	Thru Opening
E	60	H	-10	-86	76	N/A	Thru Opening
E	80	H	-2	-82	80	N/A	Thru Opening
E	100	H	-8	-91	83	N/A	Thru Opening
E	200	H	11	-80	91	N/A	Thru Opening
E	400	C	21	-83	104	N/A	Thru Opening
E	600	C	18	-81	99	N/A	Thru Opening
E	800	C	13	-78	91	N/A	Thru Opening
E	1,000	C	12	-80	92	N/A	Thru Opening
P	2,000	V	-17	-111	94	N/A	Thru Opening
P	4,000	V	8	-90	98	N/A	Thru Opening
P	6,000	V	7	-94	101	N/A	Thru Opening
P	8,000	V	-5	-109	104	N/A	Thru Opening
P	10,000	V	3	-91	94	N/A	Thru Opening
P	12,000	V	-3	-97	94	N/A	Thru Opening
P	14,000	V	-2	-99	97	N/A	Thru Opening
P	16,000	V	-3	-102	99	N/A	Thru Opening
P	18,000	V	-23	-122	99	N/A	Thru Opening

Comments:

1) Data averaged from four test samples
2) Test data taken over four month period
3) System noise floor is -135dBm

Data Sheet 6 : Ag/Al CHO-SEAL - SE After 2,000 Hours @ 125°C Dry Heat

SHIELDING EFFECTIVENESS TEST DATA

Customer:	Parker Chomerics R&D	**Date:**	11/17/2009
Product Tested:	Ag/Al CHO-SEAL	**Test No.:**	6
Tested by:	Bill Couture	**Test Spec.:**	TP-09
R&D Reference:	After 2,000 Hours @ 125°C Dry Heat		

Type of Field	Frequency MHz	Antenna Polarization	Open Reference	Closed	Shielding Effectiveness (dB)	Limits:	Open Reference
E	30	H	-37	-102	65	N/A	Thru Opening
E	40	H	-27	-90	63	N/A	Thru Opening
E	60	H	-10	-74	64	N/A	Thru Opening
E	80	H	-2	-71	69	N/A	Thru Opening
E	100	H	-8	-76	68	N/A	Thru Opening
E	200	H	11	-69	80	N/A	Thru Opening
E	400	C	21	-71	92	N/A	Thru Opening
E	600	C	18	-66	84	N/A	Thru Opening
E	800	C	13	-68	81	N/A	Thru Opening
E	1,000	C	12	-69	81	N/A	Thru Opening
P	2,000	V	-17	-103	86	N/A	Thru Opening
P	4,000	V	8	-81	89	N/A	Thru Opening
P	6,000	V	7	-89	96	N/A	Thru Opening
P	8,000	V	-5	-92	87	N/A	Thru Opening
P	10,000	V	3	-84	87	N/A	Thru Opening
P	12,000	V	-3	-85	82	N/A	Thru Opening
P	14,000	V	-2	-86	84	N/A	Thru Opening
P	16,000	V	-3	-97	94	N/A	Thru Opening
P	18,000	V	-23	-117	94	N/A	Thru Opening

Comments:

1) Data averaged from four test samples
2) Test data taken over four month period
3) System noise floor is -135dBm

Data Sheet 7 : Ag/Al CHO-SEAL - SE After 1,000 Hours @ 85°C & 85%RH

SHIELDING EFFECTIVENESS TEST DATA

Customer:	Parker Chomerics R&D	**Date:**	11/17/2009
Product Tested:	Ag/Al CHO-SEAL	**Test No.:**	7
Tested by:	Bill Couture	**Test Spec.:**	TP-09
R&D Reference:	After 1,000 Hours @ 85°C & 85% RH		

Type of Field	Frequency MHz	Antenna Polarization	Open Reference	Closed	Shielding Effectiveness (dB)	Limits:	Open Reference
E	30	H	-37	-81	44	N/A	Thru Opening
E	40	H	-27	-72	45	N/A	Thru Opening
E	60	H	-10	-55	45	N/A	Thru Opening
E	80	H	-2	-51	49	N/A	Thru Opening
E	100	H	-8	-62	54	N/A	Thru Opening
E	200	H	11	-53	64	N/A	Thru Opening
E	400	C	21	-51	72	N/A	Thru Opening
E	600	C	18	-55	73	N/A	Thru Opening
E	800	C	13	-54	67	N/A	Thru Opening
E	1,000	C	12	-55	67	N/A	Thru Opening
P	2,000	V	-17	-99	82	N/A	Thru Opening
P	4,000	V	8	-79	87	N/A	Thru Opening
P	6,000	V	7	-70	77	N/A	Thru Opening
P	8,000	V	-5	-74	69	N/A	Thru Opening
P	10,000	V	3	-75	78	N/A	Thru Opening
P	12,000	V	-3	-78	75	N/A	Thru Opening
P	14,000	V	-2	-88	86	N/A	Thru Opening
P	16,000	V	-3	-83	80	N/A	Thru Opening
P	18,000	V	-23	-103	80	N/A	Thru Opening

Comments:

1) Data averaged from four test samples
2) Test data taken over four month period
3) System noise floor is -135dBm

Data Sheet 8 : Ag/Al CHO-SEAL - SE After 500 Hrs Neutral (ASTM B117) Salt Fog

SHIELDING EFFECTIVENESS TEST DATA

Customer:	Parker Chomerics R&D	**Date:**	11/17/2009
Product Tested:	Ag/Al CHO-SEAL	**Test No.:**	8
Tested by:	Bill Couture	**Test Spec.:**	TP-09
R&D Reference:	After 500 hrs Salt Fog		

Type of Field	Frequency MHz	Antenna Polarization	Open Reference	Closed	Shielding Effectiveness (dB)	Limits:	Open Reference
E	30	H	-37	-84	47	N/A	Thru Opening
E	40	H	-27	-71	44	N/A	Thru Opening
E	60	H	-10	-54	44	N/A	Thru Opening
E	80	H	-2	-47	45	N/A	Thru Opening
E	100	H	-8	-55	47	N/A	Thru Opening
E	200	H	11	-49	60	N/A	Thru Opening
E	400	C	21	-52	73	N/A	Thru Opening
E	600	C	18	-57	75	N/A	Thru Opening
E	800	C	13	-57	70	N/A	Thru Opening
E	1,000	C	12	-56	68	N/A	Thru Opening
P	2,000	V	-17	-88	71	N/A	Thru Opening
P	4,000	V	8	-79	87	N/A	Thru Opening
P	6,000	V	7	-77	84	N/A	Thru Opening
P	8,000	V	-5	-84	79	N/A	Thru Opening
P	10,000	V	3	-79	82	N/A	Thru Opening
P	12,000	V	-3	-70	67	N/A	Thru Opening
P	14,000	V	-2	-74	72	N/A	Thru Opening
P	16,000	V	-3	-86	83	N/A	Thru Opening
P	18,000	V	-23	-106	83	N/A	Thru Opening

Comments:

1) Data averaged from four test samples
2) Test data taken over four month period
3) System noise floor is -135dBm

Figure 12 : Shielding Effectiveness: Ag/Al CHO-SEAL - Initial / Dry Heat / Humidity / Salt Fog

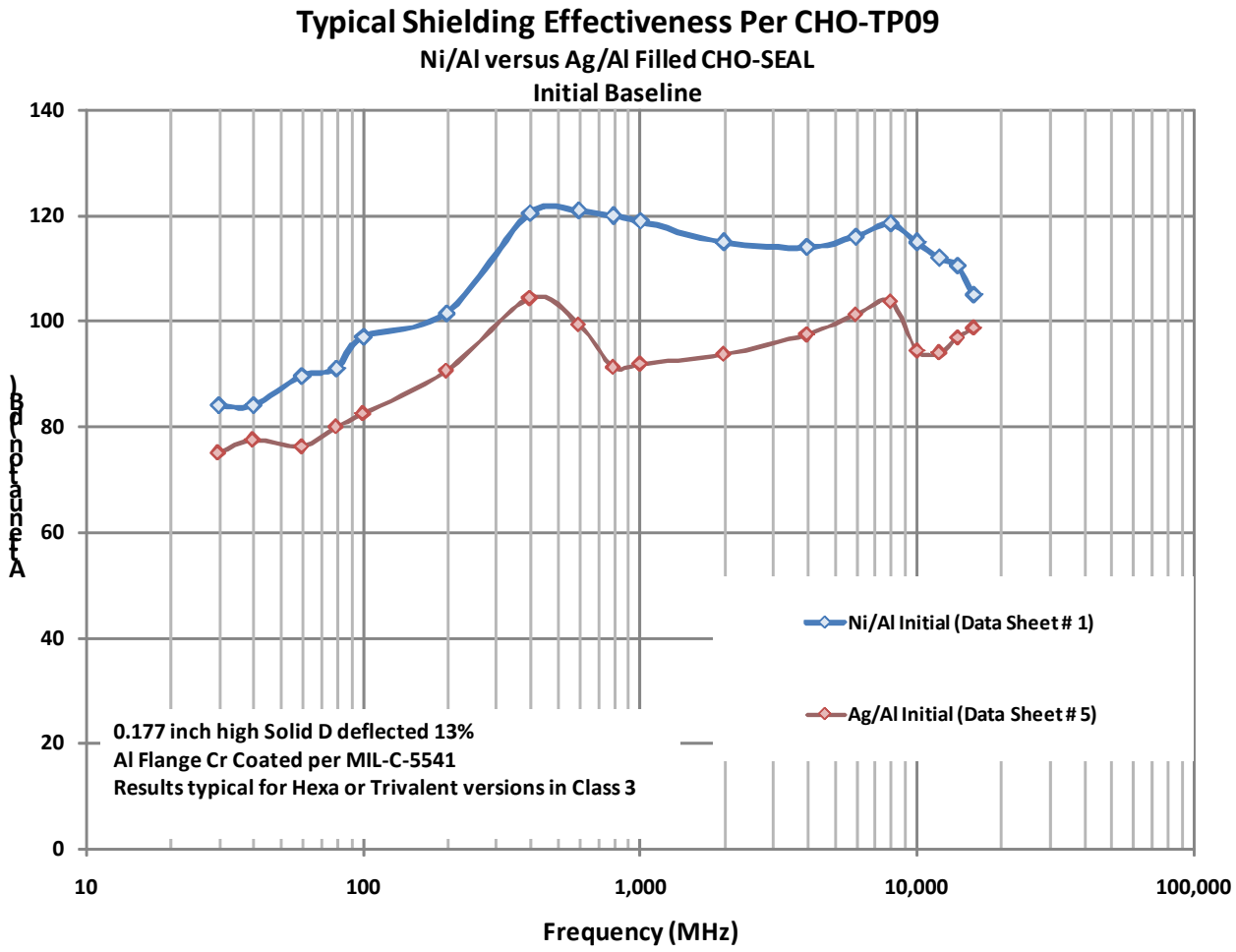


Figure 13 : Shielding Effectiveness Comparison: Ni/Al vs. Ag/Al - Initial Baseline

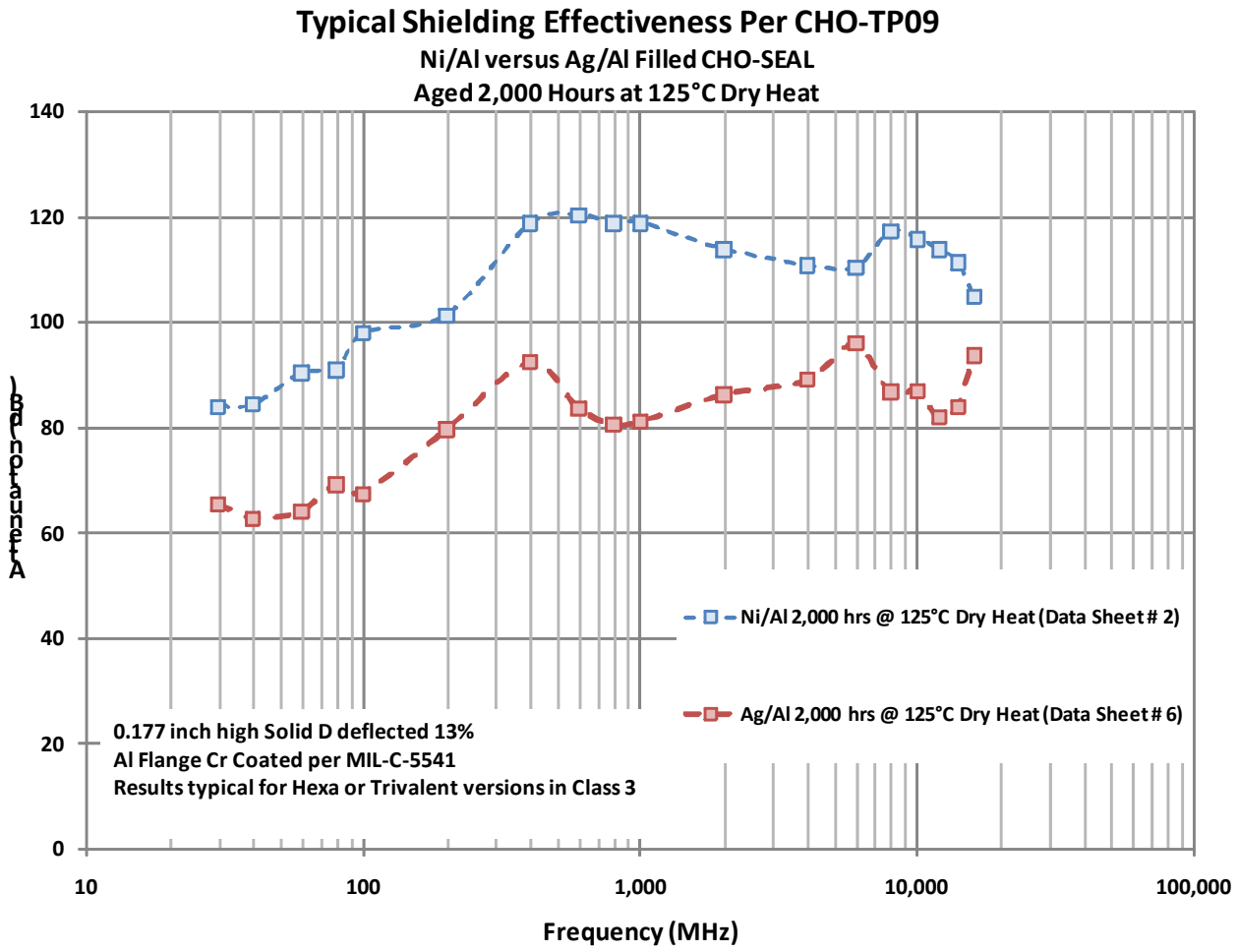


Figure 14 : Shielding Effectiveness Comparison: Ni/Al vs. Ag/Al - 2,000 Hours @ 125°C Dry Heat

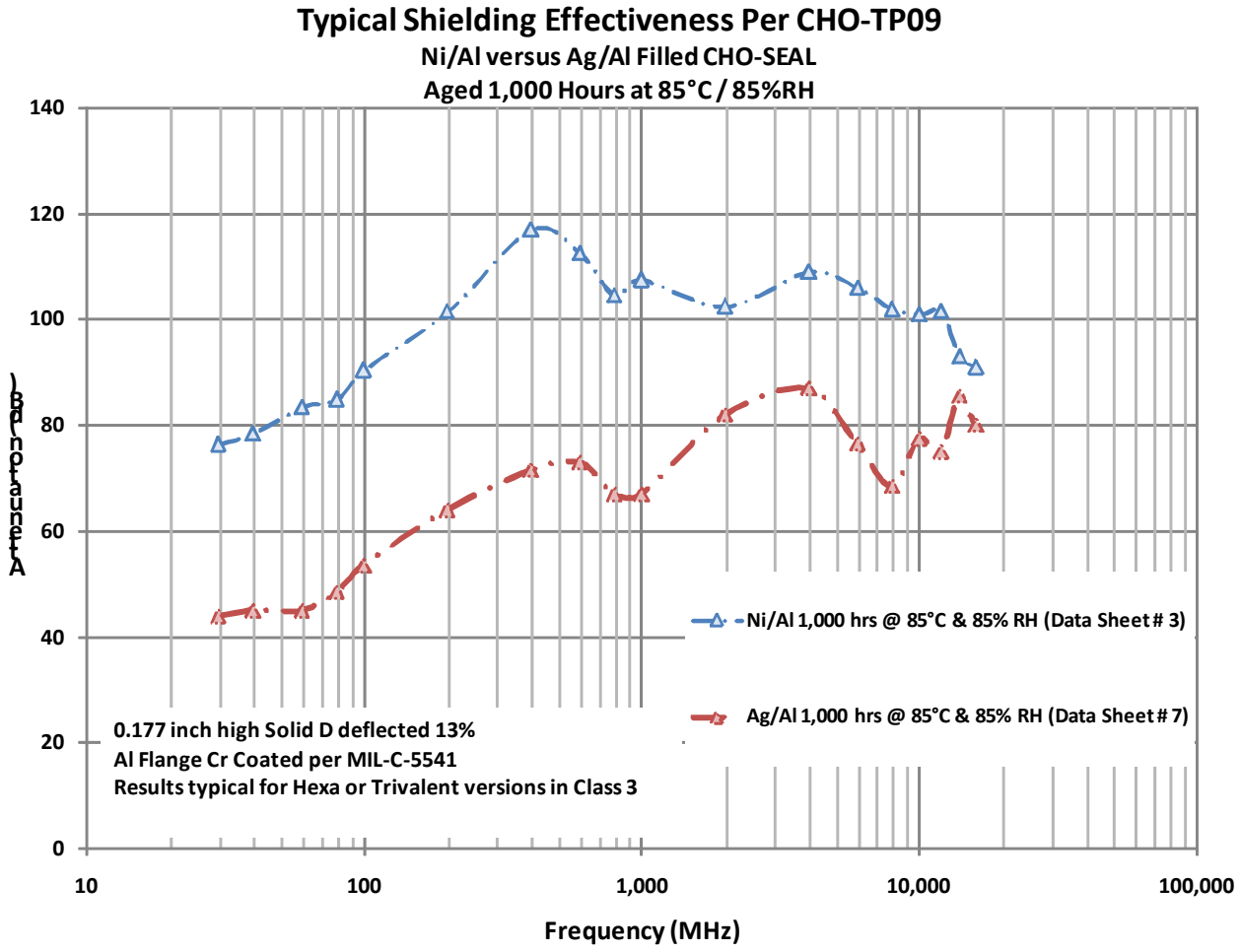


Figure 15 : Shielding Effectiveness Comparison: Ni/Al vs. Ag/Al - 1,000 Hours @ 85°C & 85% RH

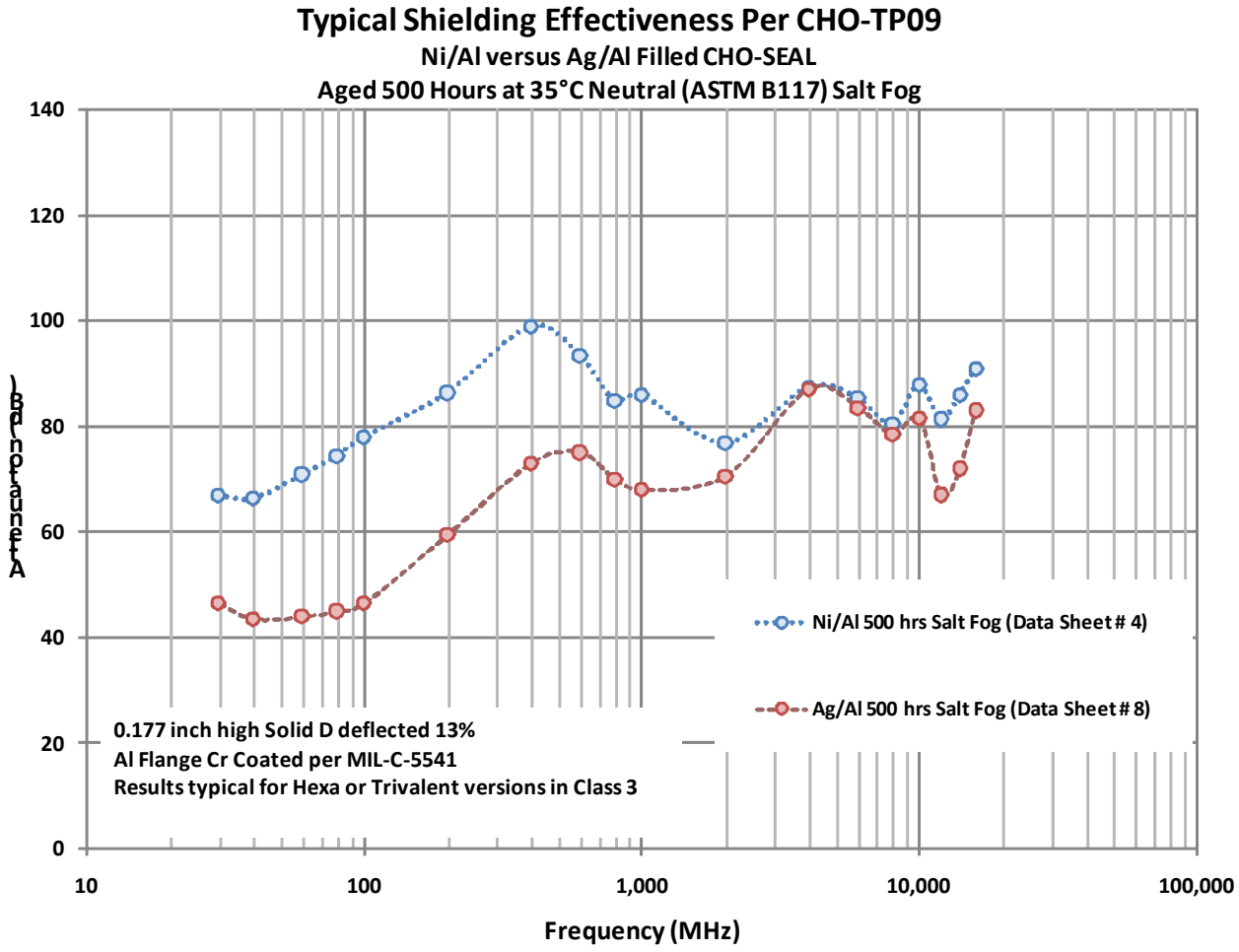


Figure 16 : Shielding Effectiveness Comparison: Ni/Al vs. Ag/Al - 500 Hours @ Salt Fog

5.4 Conclusions

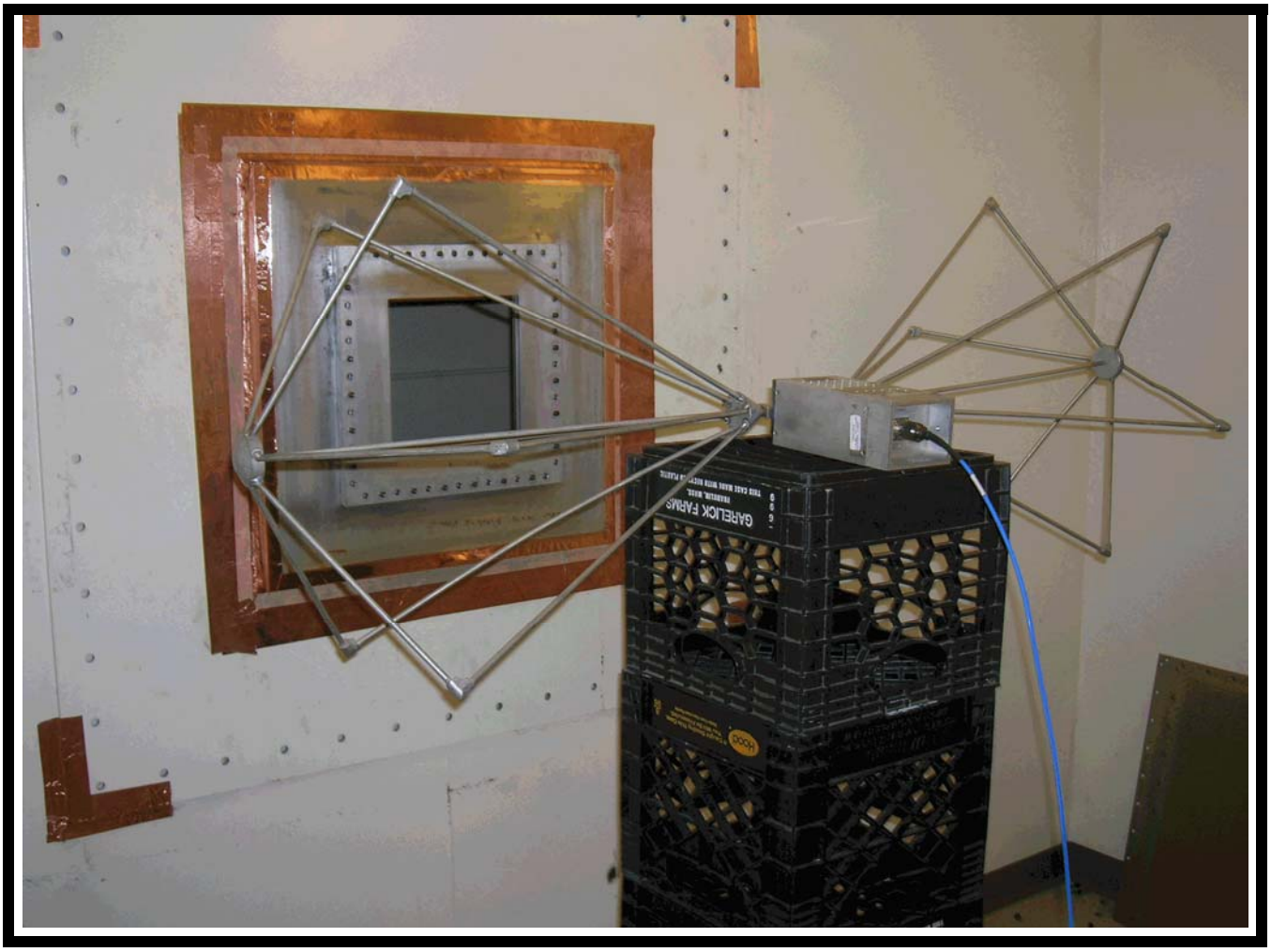
The test data included within this report illustrates that CHO-SEAL Ni/Al filled materials are superior in shielding effectiveness before and after environmental exposure compared to the CHO-SEAL Ag/Al filled equivalent.

As noted in the report, two different types of chromate conversion coatings were evaluated against both molded and extruded forms of CHO-SEAL 6502, a nickel-plated aluminum filled silicone and CHO-SEAL 6503, the Ni/Al filled fluorosilicone equivalent. These materials were similarly evaluated against CHO-SHIELD 1298, a silver-plated aluminum filled fluorosilicone gasket material. The evaluation demonstrated that within several dB, the shielding effectiveness was equivalent regardless of chromate flange treatment, elastomer binder or product form. Inclusion of the entire test package within this report was not practical, nor necessary to support this conclusion. The test data sheets and shielding effectiveness curves shown herein are a composite of results taken over several months of testing on a variety of gasket materials, flange treatments and environmental exposure conditions. Requests for specific test data shall be made through the Parker Chomerics Applications Lab or Test Services.

6 Photographic Documentation

CUSTOMER: PARKER CHOMERICS R&D
MATERIAL: CHO-SEAL NI/AL AND CHO-SEAL AG/AL
TESTED BY: WILLIAM COUTURE
OPERATING MODE: N/A

DATE: 11/17/2009
TEST NUMBER: ALL
COUPLING DEVICE: BICONICAL ANTENNA
TEST SPEC: CHO-TP09



Photograph Description: Basic Thru-Hole Open Reference Setup 20MHz to 200MHz

FORM CTS-PHOTO

CUSTOMER: PARKER CHOMERICS R&D
MATERIAL: CHO-SEAL NI/AL AND CHO-SEAL AG/AL
TESTED BY: WILLIAM COUTURE
OPERATING MODE: N/A

DATE: 11/17/2009
TEST NUMBER: ALL
COUPLING DEVICE: LOG SPIRAL ANTENNA
TEST SPEC: CHO-TP09

Photograph Description: Basic Thru-Hole Open Reference Setup 200MHz to 1GHz

FORM CTS-PHOTO

CUSTOMER: PARKER CHOMERICS R&D
MATERIAL: CHO-SEAL NI/AL AND CHO-SEAL AG/AL
TESTED BY: WILLIAM COUTURE
OPERATING MODE: N/A

DATE: 11/17/2009
TEST NUMBER: ALL
COUPLING DEVICE: HORN ANTENNA
TEST SPEC: CHO-TP09

Photograph Description: Basic Thru-Hole Open Reference Setup 1GHz to 18GHz

FORM CTS-PHOTO