

**CHO-TM101**  
**Test Method for Assessing**  
**Galvanic Corrosion Caused**  
**By Conductive Elastomers**  
  
**&**  
**TR 1044 EN November 2009**  
**Test Report on Galvanic Corrosion After 504 Hours**  
**of Salt Fog for Chomerics Cho-Seal 6502,**  
**Cho-Seal 6503, Cho-Seal 1298, Cho-Seal 1285,**  
**Cho-Seal L6303 and Cho-Seal 6370**



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# CHO-TM101

## Test Method for Assessing Galvanic Corrosion Caused By Conductive Elastomers

### 1. SCOPE

- 1.1. This is a test method to determine, in a quantitative manner, the corrosivity of conductive elastomers toward aluminum alloys and dimensional stability of the conductive elastomer after exposure to a salt fog environment.
- 1.2. This test method covers the selection of materials, specimen preparation, test environment, method of exposure, and method of evaluating results in order to characterize conductive elastomer/aluminum alloy galvanic couples in a corrosive environment.
- 1.3. This test method may involve the use of hazardous materials. The procedures described herein do not address all of the safety issues associated with their use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

### 2. APPLICABLE DOCUMENTS

#### 2.1. ASTM Standards

- 2.1.1. B117 Method of Salt Spray (Fog) Testing
- 2.1.2. G1 Preparing, Cleaning, and Evaluating Corrosion Test Specimens
- 2.1.3. G46 Examination and Evaluation of Pitting Corrosion

#### 2.2. Military Standards

- 2.2.1. MIL-C-5541E Chemical Conversion Coatings on Aluminum and Aluminum Alloys

### 3. SIGNIFICANCE AND USE

- 3.1. Conductive gaskets are used to seal apertures in electronics enclosures and airframes against leakage of electromagnetic radiation. Metal filled elastomers (conductive elastomers) are one type of "EMI gasket" used for this purpose. Conductive elastomers consist of small (typ. 30 to 150 micron) metal particles in an elastomer binder. The elastomer binder is highly loaded with the metal filler to provide low volume resistivity, in use, these conductive elastomers are compressed between mating surfaces so that a low impedance bond is formed.
- 3.2. Aircraft structures and electronic enclosures are typically made from aluminum alloys. When these aluminum alloys are sealed with conductive elastomers and exposed to a salt fog environment, the necessary and sufficient conditions for galvanic corrosion exist: two dissimilar metals, electrolyte, and an electronic path.
  - 3.2.1. The aluminum alloy is the more active material in a conductive elastomer /aluminum alloy galvanic couple. Corrosion of the aluminum alloy can lead to pitting (and in severe cases to structural damage) and build-up of non-conductive corrosion products between the conductive elastomer and aluminum alloy enclosure or airframe structure.

3.2.2. The conductive elastomer is the more noble material in the conductive elastomer/aluminum alloy galvanic couple.

3.3. This test method describes procedures for assigning a quantitative value to the corrosivity of a conductive elastomer and measuring its electrical and dimensional stability after exposure to a salt fog environment.

3.3.1. The corrosivity of the conductive elastomer is determined by measuring the weight loss of an aluminum alloy test coupon after exposure of the galvanic couple to a salt fog environment

3.3.2. The dimensional stability of the conductive elastomer is determined by measuring its thickness before and after exposure of the galvanic couple to a salt fog environment.

3.4. The values obtained for aluminum alloy weight loss, and dimensional changes are indicative of corrosivity and stability of the conductive elastomer aluminum alloy flange interface in a salt fog test environment. Care should be used in applying the absolute values obtained to other test environments or to a natural environment.

#### 4. EQUIPMENT AND TEST SPECIMENS

4.1. The test fixture is shown in Figure 1. The conductive elastomer and aluminum coupon are held in contact by compression between two cylindrical Delrin blocks. Compressive force is supplied by a central 3.25" (8.26cm) long 1/4-20, 18-8 stainless steel bolt and an 18-8 stainless steel nut. Fluid is prevented from penetrating to the bolt-conductive elastomer /aluminum alloy coupon interface by use of non-conductive silicone sealing washer, between the bolt head and the upper Delrin block and between the bottom of the aluminum coupon and the lower Delrin block.

4.1.1. The aluminum alloy coupon and conductive elastomer test specimen are shown in detail in Figure 2. The circular aluminum coupon has a 1.75" (4.45cm) outer diameter with a 0.25" (0.64cm) hole in the center. It should be machined from an aluminum sheet on a lathe and should not be formed by stamping. The coupon should be of a thickness such that it does not pit through during exposure to the corrosive environment. For 168 hours exposure, a

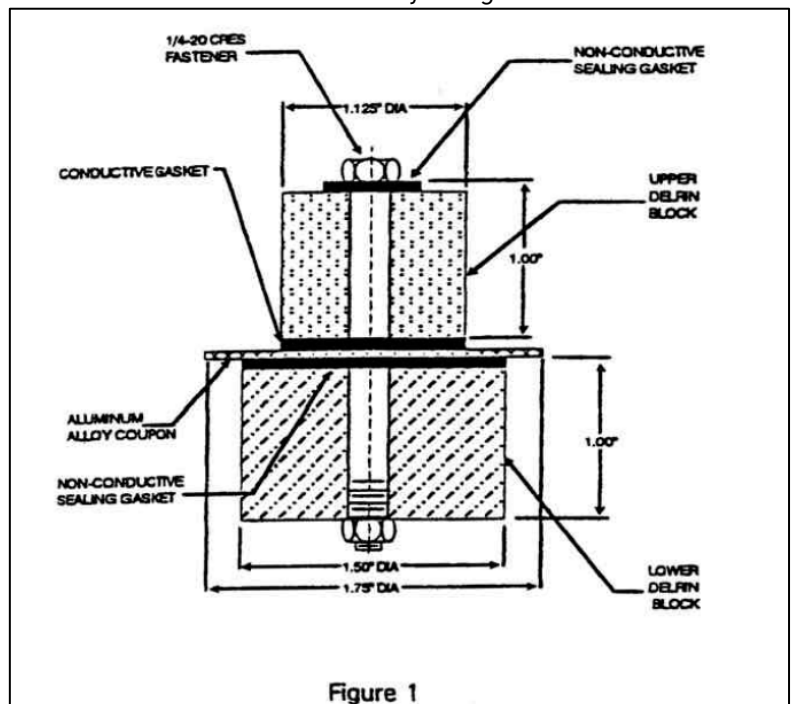


Figure 1

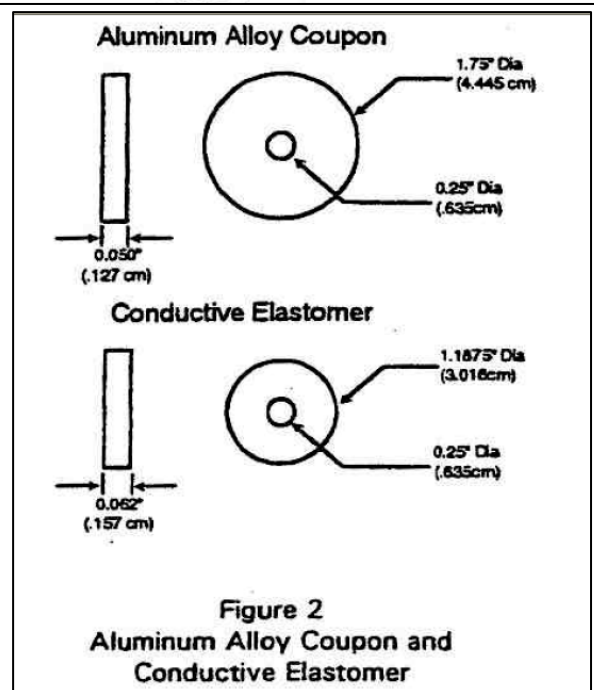
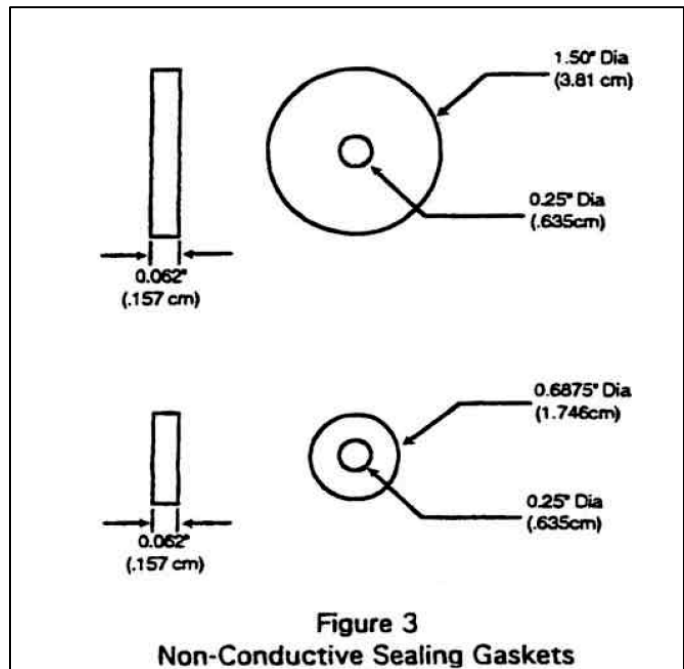


Figure 2  
Aluminum Alloy Coupon and  
Conductive Elastomer

0.05" (0.127cm) thick coupon of 6061-T6 aluminum alloy is recommended. The coupon may be chromate conversion coated or plated with nickel, tin or silver or any other coating depending on what flange-conductive elastomer system is being evaluated. Typically hexavalent chromate conversion coatings are per MIL-DTL-5541F Type 1 Class 3, trivalent chromate conversion coatings are per MIL-DTL-5541F Type 2 Class 3.

4.1.2. The conductive elastomer specimen is a washer of 1.141"  $\pm$  0.010" (2.90cm  $\pm$  0.0254cm) outer diameter with a 0.25"  $\pm$  0.005" (0.64cm  $\pm$  0.0127cm) center hole. The elastomer should be 0.062"  $\pm$  0.007" (0.157"  $\pm$  0.0178cm) thick. Deviations to these dimensions from the nominal value may affect the results. The conductive elastomer washer should be formed by die-cutting from sheet stock.

4.1.3. Figure 3 shows the nonconductive sealing gaskets in more detail. They should be made from a silicone rubber of 45 Shore A hardness. The sealing gasket used underneath the aluminum coupon should be a washer of 1.5" (3.81 cm) outer diameter with a 0.25" (0.64 cm) hole in the center. A thickness of 0.062" (0.157 cm) is recommended. The sealing gasket used under the bolt head should be a washer of 0.6875" (1.746 cm) outer diameter with a 0.25" (0.64 cm) hole in the center.

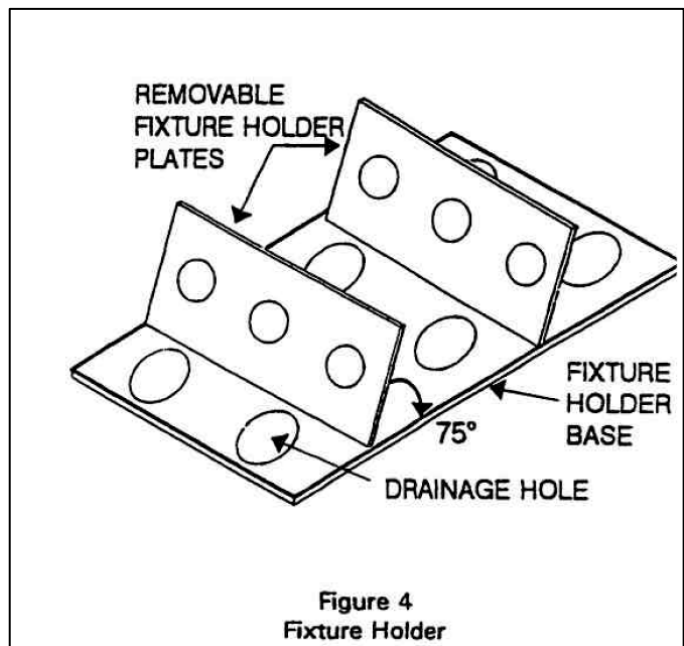


4.2. The fixture holder is shown in Figure 4. The intent of the fixture holder is to hold the test fixture at a fixed angle in the test chamber. This angle should be 75° to the horizontal. The fixture holder should be made from nonmetallic, inert materials.

4.3. Weights of aluminum alloy coupons should be measured on an analytical balance capable of  $\pm$ 0.1 mg precision.

4.4. The thickness of the conductive elastomer shall be measured with a thickness gauge capable of  $\pm$  .025 mm precision.

4.5. A Sharpie fine point permanent marker (or equivalent) can be used to mark aluminum and conductive elastomer samples for identification.



## 5. ASSEMBLY PROCEDURE AND PRE-EXPOSURE MEASUREMENTS

- 5.1. No less than two test assemblies of each conductive elastomer type shall be exposed for each test.
- 5.2. Mark each aluminum alloy disk with a sample number.  
Note 1: The aluminum alloy disks should be handled with gloves so as to prevent fingerprints and soil from causing weighing errors.
- 5.3. Mark each conductive elastomer specimen with a sample number.
- 5.4. Weigh the aluminum alloy coupons and record the weights.
- 5.5. To assemble the fixture, start by placing the smaller non-conductive gasket under the head of the stainless steel bolt. Insert the bolt through the upper Delrin block, through the conductive elastomer, through the aluminum alloy coupon, through the lower Delrin block and through the fixture holder plate. Place any needed washers and the hex nut off the threaded portion of the bolt. Apply sufficient torque to the bolt so that the conductive elastomer is deflected 10% [about 8 in-lbs (.9N m) for most filled silicones]. Repeat this procedure for each fixture.
- 5.6. After assembling the fixtures onto the fixture holder plates, the plates should be placed into the fixture holder base.

## 6. TEST CONDITIONS

- 6.1. The fixtures should be exposed to neutral salt fog according to the conditions given in ASTM B117.
- 6.2. Exposure periods ranging from 72 to 500 hours have been used. An exposure period of 168 hours (1 week) is recommended.

## 7. EVALUATION OF SPECIMENS

- 7.1. The fixtures should be removed from the salt fog chamber at the end of the exposure period. Disassemble the fixtures and rinse the aluminum alloy coupons with deionized water. Loosely adhered corrosion products can be removed with a soft nylon brush.
- 7.2. The aluminum alloy coupons should be further cleaned of corrosion products using a modification of the procedure given in ASTM G 1-88. The coupons are placed in 1.42 specific gravity (concentrated) nitric acid for 15 minutes. After removal from the nitric acid the disks should be rinsed in deionized water, blotted dry, and relabeled with the marking pen (if necessary) Note 2: Concentrated nitric acid should be used in a fume hood and proper safety equipment should be worn.
- 7.3. Dry the aluminum alloy coupons for 2 hours at 100°C. Coupons should be placed in a desiccator and allowed to cool to room temperature.
- 7.4. Reweigh the coupons on a balance capable of +/-0.1 mg precision and record the results.
- 7.5. Measure and record the thickness of the portion of the conductive elastomer specimen showing the maximum dimensional change.

## 8. INTERPRETATION AND CALCULATION OF

8.1. The corrosivity of the conductive elastomer is proportional to the weight loss of the aluminum alloy coupon.

8.1.1. Calculate the aluminum alloy coupon weight loss according to:  
Weight Loss (mg) = [Initial Weight (g) – Final Weight (g)] x 1000

8.1.2. Calculate the average coupon weight loss for each conductive elastomer type.

8.2. The dimensional stability of a conductive elastomer is related to its ability to continue to provide an EMI and environmental seal during environmental exposure.

8.2.1. Calculate the maximum percent dimensional change of the conductive elastomer specimen according to:

$$\% \text{ Dimensional Change} = \frac{\text{final thickness} - \text{initial thickness}}{\text{initial thickness}} \times 100$$

8.2.2. Calculate the average maximum percent dimensional change for each conductive elastomer type.

## 9. REPORT

9.1. A test report containing the following information shall be issued at the completion of the test. It must include each of the following elements.

9.1.1. The exposure time in salt fog.

9.1.2. The aluminum alloy exposed and any corrosion coating, plating, or other surface finish applied.

9.1.3. The weight loss for each aluminum alloy coupon.

9.1.4. The average weight loss of the aluminum alloy coupons for each type of conductive elastomer.

9.1.5. The maximum percent dimensional change of each conductive elastomer specimen.

9.1.6. The average maximum percent dimensional change for each conductive elastomer type.

9.2. A suggested Word document form for reporting the results is given in the Appendix.

# APPENDIX

## CHO-TM101 (SALT FOG) TEST RESULTS

<b>Material</b>					
<b>Filler</b>					
<b>Notebook #</b>					
<b>Description</b>					
<b>Exposure Time (hours)</b>					
<b>Coupon Type</b>					
<b>Surface Treatment</b>					
<b>Average Weight Loss (mg)</b>					
<b>Std. Dev.</b>					
<b>Maximum Dim. Change (%)</b>					
<b>Average Dim. Change (%)</b>					

CHO-TM101 – Related Information

Conductive Elastomer Washer:

Die-cut using RD# 15416

Coupons, aluminum or stainless steel:

Purchase from:  
GTG Precision Machining  
3 Birch Road  
P.O Box 366  
Middleton, MA 01949

Filter cloth, # 401800:

Purchase from:  
Singleton Corp.  
3280 W. 67<sup>th</sup> Place  
Cleveland, OH 44102

Nitric Acid:

Purchase from:  
Fisher Scientific, A483-212, NF grade or;  
VWR International, VW4815-6, Reagent ACS

Nitric Acid Waste:

Store in metal covered glass jars until disposed of:  
label as 100% Nitric acid waste or < 1% Nitric acid waste (rinse step)

Red Silicone Rubber:

Reference # 4455-94

Sodium Chloride (Salt):

Purchase from:  
Fisher Scientific, S271-50, Cert. ACS

# **TR 1044 EN November 2009**

## **Test Report on Galvanic Corrosion After 504 Hours of Salt Fog for Chomerics Cho-Seal 6502, Cho-Seal 6503, Cho-Seal 1298, Cho-Seal 1285, Cho-Seal L6303 and Cho-Seal 6370**

**Purpose:** This document is to report the weight loss due to galvanic corrosion after 504 hours of salt fog exposure of several grades of Electromagnetic Interference (EMI) Shielding conductive elastomer gasket materials. All testing was done in accordance with CHO-TM-10. The results can be used to judge the relative resistance to galvanic corrosion of chromate conversion coated aluminum flanges when these grades of elastomers are used. This is intended to assist design engineers in selecting the proper material for their application based on the end use environment.

### **Materials Tested:**

#### Elastomers

- Cho-Seal 6502 in both extruded and molded form. The material is a silicone based elastomer filled with nickel plated aluminum particles (Ni/Al). Data is reported on Tables 1 & 2.
- Cho-Seal 6503 in both extruded and molded form. The material is a fluorosilicone based elastomer filled with nickel plated aluminum particles (Ni/Al). Data is reported on Tables 3 & 4.
- Cho-Seal 1298 in extruded form only. The material is a fluorosilicone based elastomer filled with silver plated aluminum particles (Ag/Al). Data is reported on Table 5.
- Cho-Seal 1285 in extruded form only. The material is a silicone based elastomer filled with silver plated aluminum particles (Ag/Al). Data is reported on Table 6.
- Cho-Seal L6303 in extruded form only. The material is a fluorosilicone based elastomer filled with nickel plated graphite particles (Ni/Gr). Data is reported on Table 7.
- Cho-Seal 6370 in extruded form only. The material is a silicone based elastomer filled with nickel plated graphite particles (Ni/Gr). Data is reported on Table 8.

For each grade of elastomer four chromate conversion coating grades were tested

- Hexavalent chromium Class 1A per MIL-G-5541
- Hexavalent chromium Class 3 per MIL-G-5541
- Trivalent chromium Class 1A per MIL-G-5541
- Trivalent chromium Class 3 per MIL-G-5541

### **Results**

The corrosion weight loss can be grouped by filler type. Ni/Al performed best followed by Ag/Al and Ni/Gr performed the worst. Within each filler grade the fluorosilicone performed better than the silicone. Difference in processing between molding and extrusion has minimal effect on corrosion. The appears to be only a minimal effect of hexavalent versus trivalent and Class 1A versus Class 3.

Based on this data the filler material is the most significant driver of performance and Ni/Al materials performed the best. On page 14 pictures of typical appearance are shown.

Table 1 Ni/Al filled Silicone Extrusion

Description	6502E extruded	6502E extruded	6502E extruded	6502E extruded
Conductive filler	Ni/Al	Ni/Al	Ni/Al	Ni/Al
Ni/Al lot#	QC09-030			
Binder system	Silicone	Silicone	Silicone	Silicone
Note-book reference #4499	40-13, 14, 15	40-16, 17, 18	40-19, 20, 21	40-22, 23, 23
Coupon type: 6061 Al	Hexavalent Class 1A	Hexavalent Class 3	Trivalent Class 1A	Trivalent Class 3
Exposure Time (hours)	504	504	504	504
Raw weight loss data (mg)	20 14 12	7 11 10	15 21 13	17 22 14
Mean weight loss (mg)	16	9	16	18
Median weight loss (mg)	14	10	15	17
Std dev.	4	2	4	4
Coefficient of variation (%)	26	26	27	22

Table 2 Ni/Al filled Silicone Molded

Description	6502 molded	6502 molded	6502 molded	6502 molded
Conductive filler	Ni/Al	Ni/Al	Ni/Al	Ni/Al
Ni/Al lot#	QC09-016			
Binder system	Silicone	Silicone	Silicone	Silicone
Note-book ref. #4499	41-1, -2, -3	41-4, -5, -6	41-7, -8, -9	41-10, -11, -12
Coupon type: 6061 Al	Hexavalent Class 1A	Hexavalent Class 3	Trivalent Class 1A	Trivalent Class 3
Exposure Time (hours)	504	504	504	504
Raw weight loss data (mg)	15 13 13	10 15 13	17 21 18	16 12 15
Mean weight loss (mg)	14	13	19	14
Median weight loss (mg)	13	13	18	15
Std dev.	1	3	2	2
Coefficient of variation (%)	8	20	10	17

Table 3 Ni/Al filled Fluorosilicone Extrusion

Description	6503E extruded	6503E extruded	6503E extruded	6503E extruded
Conductive filler	Ni/Al	Ni/Al	Ni/Al	Ni/Al
Ni/Al lot#	QC09-030			
Binder system	Fluorosilicone	Fluorosilicone	Fluorosilicone	Fluorosilicone
Note-book ref. #4499	41-13, -14, -15	41-16, -17, -18	41-19, -20, -21	41-22, -23, -24
Coupon type: 6061 Al	Hexavalent Class 1A	Hexavalent Class 3	Trivalent Class 1A	Trivalent Class 3
Exposure Time (hours)	504	504	504	504
Raw weight loss data (mg)	12 10 9	2 9 10	12 11 15	7 22 21
Mean weight loss (mg)	10	7	13	17
Median weight loss (mg)	10	9	12	21
Std dev.	1	4	2	8
Coefficient of variation (%)	13	56	16	49

Table 4 Ni/Al filled Fluorosilicone Molded

Description	6503 molded	6503 molded	6503 molded	6503 molded
Conductive filler	Ni/Al	Ni/Al	Ni/Al	Ni/Al
Ni/Al lot#	QC09-030			
Binder system	Fluorosilicone	Fluorosilicone	Fluorosilicone	Fluorosilicone
Note-book ref. #4499	42-1, -2, -3	42-4, -5, -6	42-7, -8, -9	42-10, -11, -12
Coupon type: 6061 Al	Hexavalent Class 1A	Hexavalent Class 3	Trivalent Class 1A	Trivalent Class 3
Exposure Time (hours)	504	504	504	504
Raw weight loss data (mg)	7 4 10	11 6 11	8 11 8	13 6 11
Mean weight loss (mg)	7	9	9	10
Median weight loss (mg)	7	11	8	11
Std dev.	3	2	2	4
Coefficient of variation (%)	41	26	22	38

Table 5 Ag/Al filled Fluorosilicone Extrusion

Description	1298E extruded	1298E extruded	1298E extruded	1298E extruded
Conductive filler	Ag/Al	Ag/Al	Ag/Al	Ag/Al
Ni/Al lot#	N/A			
Binder system	Fluorosilicone	Fluorosilicone	Fluorosilicone	Fluorosilicone
Note-book reference #4499	40-1, 2, 3	40-4, 5, 6	40-7, 8, 9	40-10, 11, 12
Coupon type: 6061 Al	Hexavalent Class 1A	Hexavalent Class 3	Trivalent Class 1A	Trivalent Class 3
Exposure Time (hours)	504	504	504	504
Raw weight loss data (mg)	33 28 35	20 35 20	24 25 52	25 16 18
Mean weight loss (mg)	32	25	34	20
Median weight loss (mg)	33	20	25	18
Std dev.	3	9	16	4
Coefficient of variation (%)	10	34	47	23

Table 6 Ag/Al filled Silicone Extrusion

Description	1285E extruded	1285E extruded	1285E extruded	1285E extruded
Conductive filler	Ag/Al	Ag/Al	Ag/Al	Ag/Al
Binder system	Silicone	Silicone	Silicone	Silicone
Note-book ref. #4499	77-1, -2, -3	77-4, -5, -6	77-7, -8, -9	73-10, -11, -12
Coupon type: 6061 Al	Hexavalent Class 1A	Hexavalent Class 3	Trivalent Class 1A	Trivalent Class 3
Exposure Time (hours)	504	504	504	504
Raw weight loss data (mg)	37 28 30	53 40 26	35 102 29	64 43 38
Mean weight loss (mg)	31	40	56	49
Median weight loss (mg)	30	40	35	43
Std dev.	5	14	40	14
Coefficient of variation (%)	15	34	73	29

Table 7 Ni/Gr filled Fluorosilicone Extruded

Description	L6303E extruded	L6303E extruded	L6303E extruded	L6303E extruded
Conductive filler	Ni/Gr	Ni/Gr	Ni/Gr	Ni/Gr
Binder system	Fluorosilicone	Fluorosilicone	Fluorosilicone	Fluorosilicone
Note-book ref. #4499	73-1, -2, -3	73-4, -5, -6	73-7, -8, -9	73-10, -11, -12
Coupon type: 6061 Al	Hexavalent Class 1A	Hexavalent Class 3	Trivalent Class 1A	Trivalent Class 3
Exposure Time (hours)	504	504	504	504
Raw weight loss data (mg)	121 108 106	103 106 109	116 107 114	94 131 113
Mean weight loss (mg)	112	106	112	113
Median weight loss (mg)	108	106	114	113
Std dev.	8	3	5	18
Coefficient of variation (%)	7	3	4	16

Table 8 Ni/Gr filled Silicone Extruded

Description	6370 extruded	6370 extruded	6370 extruded	6370 extruded
Conductive filler	Ni/Gr	Ni/Gr	Ni/Gr	Ni/Gr
Binder system	Silicone	Silicone	Silicone	Silicone
Note-book ref. #4499	73-13, -14, -15	73-16, -17, -18	73-19, -20, -21	73-22, -23, -24
Coupon type: 6061 Al	Hexavalent Class 1A	Hexavalent Class 3	Trivalent Class 1A	Trivalent Class 3
Exposure Time (hours)	504	504	504	504
Raw weight loss data (mg)	142 147 153	247 189 183	169 175 189	226 242 150
Mean weight loss (mg)	147	207	178	206
Median weight loss (mg)	147	189	175	226
Std dev.	5	35	11	49
Coefficient of variation (%)	4	17	6	24



**Cho-Seal 6503  
Molded**



**Cho-Seal 6503  
Extruded**



**Cho-Seal 6502  
Molded**



**Cho-Seal 6502  
Extruded**



**Cho-Seal 1298**



**Cho-Seal 1285**



**Cho-Seal L6303**



**Cho-Seal 6370**