Hexavalent Chrome Free Coatings for Electronics

Electromagnetic Interference (EMI)

Shielding Effectiveness (SE)

Objective

Determine the suitability of trivalent chromium conversion coatings that meet the requirements of MIL-DTL-5541, Type II, for use in applications where high-frequency electrical performance is important.

- Evaluate the ability of hexavalent chrome free pretreated aluminum to form adequate EMI seals, and maintain that seal while being subjected to harsh environmental conditions
- Assess the performance of trivalent chromium pretreatments against a known control hexavalent chrome pretreatment before and after they have been exposed to a set of environmental conditions
  - It is known that environmental testing causes a decrease in shielding effectiveness when hexavalent chrome pretreatments are used (Alodine 1200s)
  - Need to determine how shielding effectiveness will be affected with the use of hexavalent chrome free pretreatments
- Performance will be assessed by evaluating shielding effectiveness (SE) test data from a variety of test samples comprised of different aluminum types and/or conversion coatings
- The formation of corrosion will be evaluated between the mating surfaces and gasket to assess the corrosion resistant properties of the pretreatments, comparing the hexavalent control to the hexavalent chrome free pretreatments

Materials

Alloys

- 5052-H32
- 6061-T6

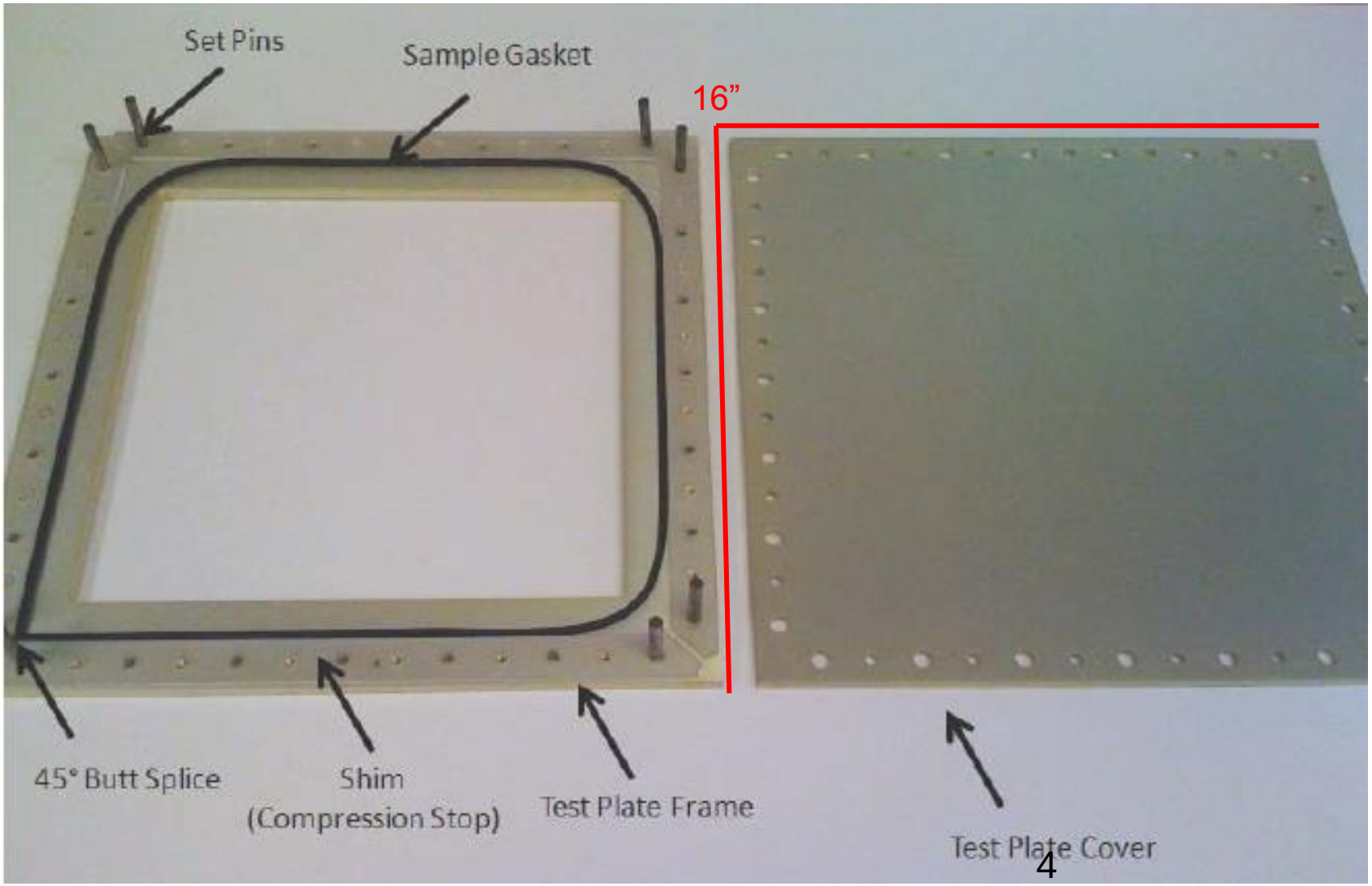
Pretreatments

- MIL-DTL-5541, Type I, Class 3, Hexavalent {Control}
- MIL-DTL-5541, Type II, Class 3, SurTec 650
- MIL-DTL-5541, Type II, Class 3, Metalast TCP

EMI Gasket

- Cho-Seal 6503E - nickel-aluminum filled fluorosilicone
- Following internal Chomerics testing, Cho-Seal 6503E EMI gasket material exhibited superior galvanic weight loss and dimensional change after 504 hours of salt fog exposure regardless of alloy. Testing included Alodine 1200S, SurTec 650 and Metalast TCP-HF.

Test Articles



Testing Overview

Test	Test Method	Duration	Evaluation Criteria	Location
Thermal Preconditioning	0°C to 100°C	100 Cycles	N/A	TBD
EMI Testing	IEEE-STD-299	**	**	Chomerics
Salt Spray Resistance	ASTM B 117	168 Hours	MIL-DTL-5541	KSC Corrosion Lab
Static Heat and Humidity	85°C +/- 1°C and 85% RH +/- 5% RH	1,000 Hours	MIL-DTL-5541	KSC Corrosion Lab
Marine Environment	ASTM D 1014	12 Months	NASA-STD-4003	KSC Corrosion Lab

** For each test area or test point, shielding effectiveness measurements shall be made at the following test frequencies: 50, 100, 250, 300, 400, 500, 600, 700, 800, 900, 1000 MHz for electric field and 2, 4, 6, 8, 10, 12, 14, 16 and 18GHz for plane wave shielding effectiveness measurements.

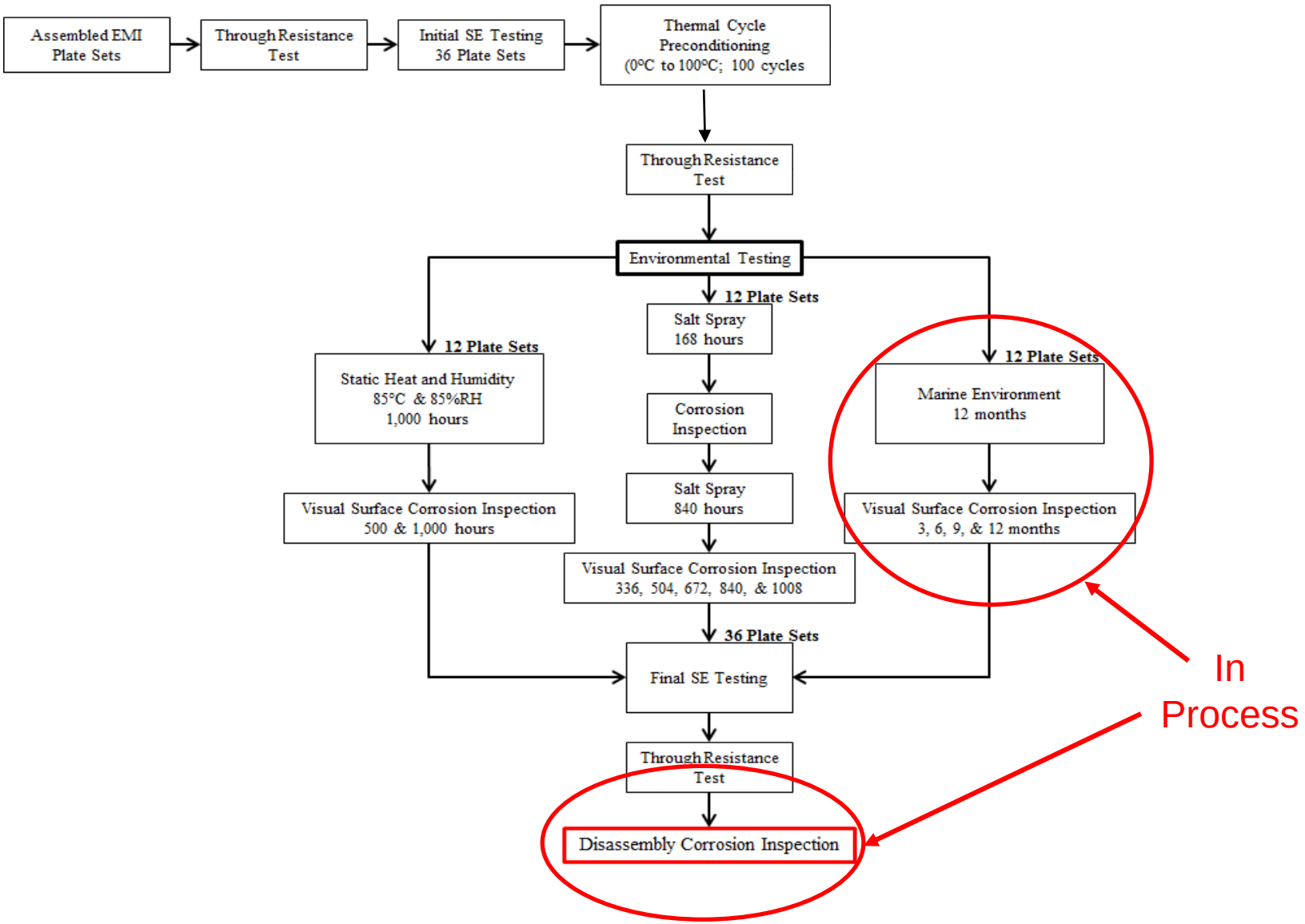
Stakeholder Contributions

Project Task	Funding Source
Project management	NASA
Test plate fabrication	Northrop Grumman
Pretreatment Processing	Lockheed Martin
Miscellaneous materials	Lockheed Martin
EMI gaskets	Chomerics
Shipping crates	Harris
Initial shielding effectiveness testing	Chomerics
Initial resistance testing	Chomerics
Thermal preconditioning	Raytheon
Secondary shielding effectiveness testing	Chomerics
Contact electrical resistance testing	UTC Aerospace
Surface resistivity testing	Raytheon
Salt spray testing	NASA
Static heat and humidity testing	NASA
Marine environment testing	NASA
Final shielding effectiveness testing	Chomerics

Testing Overview

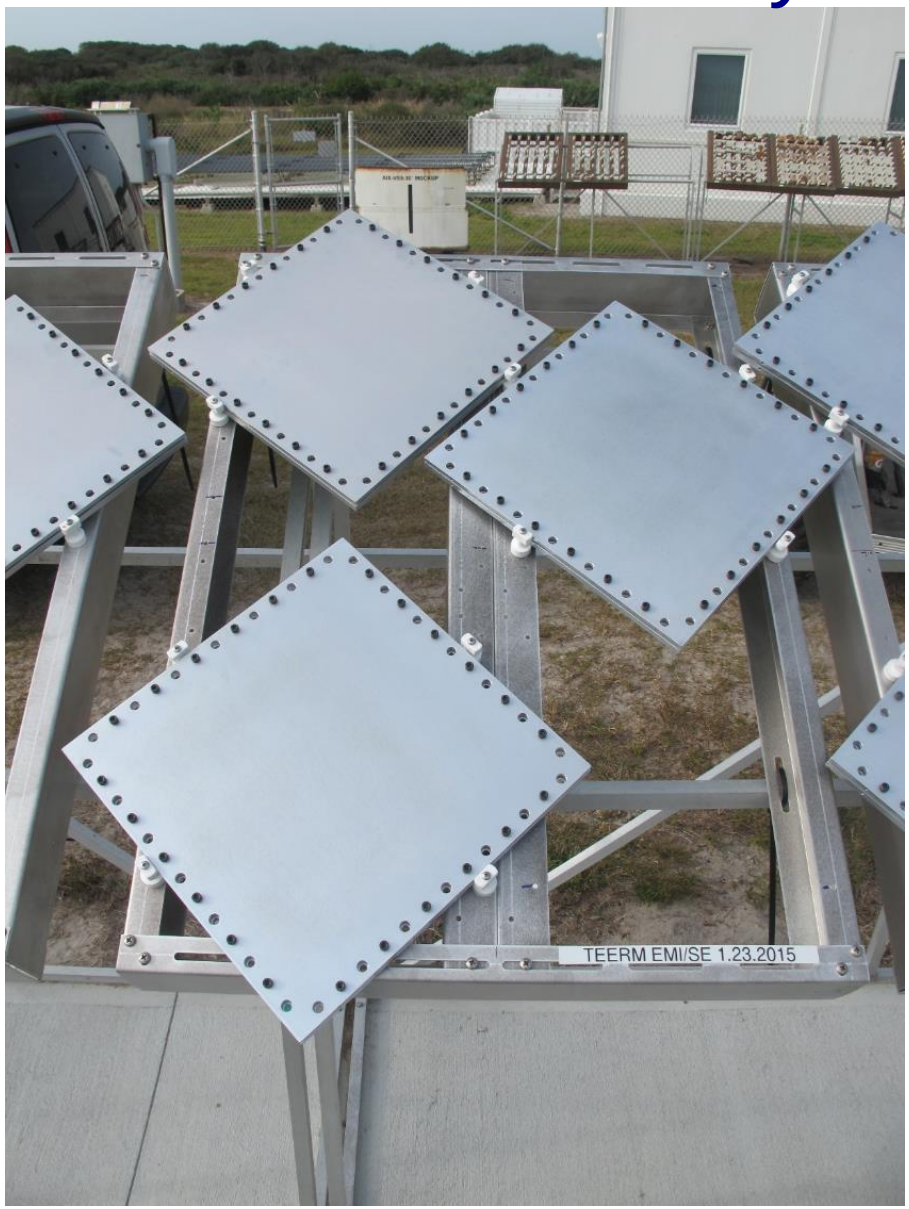
Test	Test Method	Duration	Evaluation Criteria	Location	
Thermal Preconditioning	0°C to 100°C	100 Cycles	N/A	TBD	Complete
EMI Testing {Pre}	Chomerics CHO-TP09	50 MHz – 18 GHz with 3 freq's/decade	Chomerics	Chomerics	Complete
Salt Spray Resistance	ASTM B 117	168 Hours then 1,008 Hours	MIL-DTL-5541	KSC Corrosion Lab	Complete
Static Heat and Humidity	85°C +/- 1°C and 85% RH +/- 5% RH	1,000 Hours	MIL-DTL-5541	KSC Corrosion Lab	Complete
Marine Environment	ASTM D 1014	12 Months	MIL-DTL-5541	KSC Corrosion Lab	In Process
EMI Testing {Post}	Chomerics CHO-TP09	50 MHz – 18 GHz with 3 freq's/decade	Chomerics	Chomerics	2/3 Complete

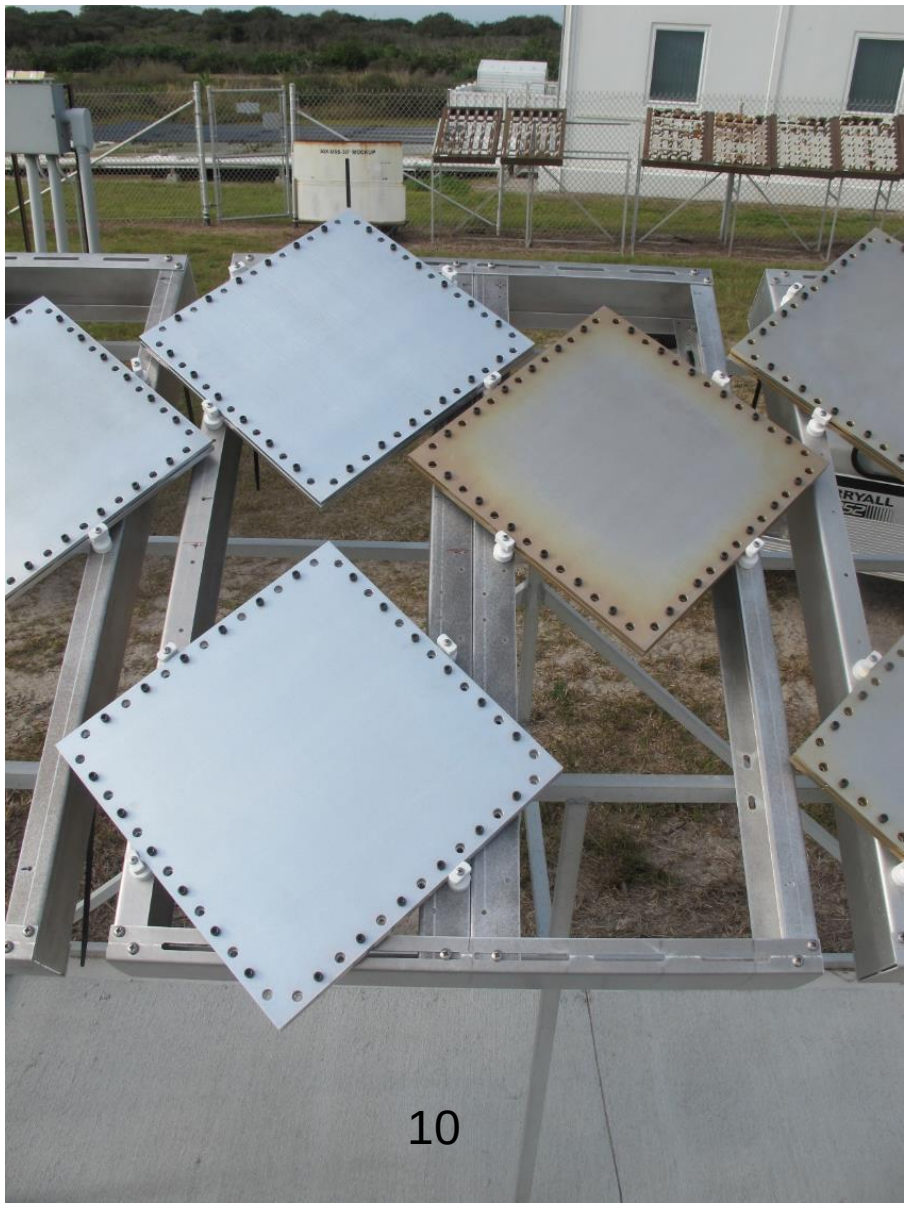
Test Flow


Assembled EMI Plate Sets
Through Resistance Test
Initial SE Testing 36 Plate Sets
Thermal Cycle Preconditioning (0°C to 100°C; 100 cycles
Through Resistance Test
Environmental Testing
12 Plate Sets
Salt Spray 168 hours
Corrosion Inspection
Salt Spray 840 hours
Visual Surface Corrosion Inspection 336, 504, 672, 840, & 1008
12 Plate Sets
Static Heat and Humidity 85°C & 85%RH 1,000 hours
Visual Surface Corrosion Inspection 500 & 1,000 hours
12 Plate Sets
Marine Environment 12 months
Visual Surface Corrosion Inspection 3, 6, 9, & 12 months
36 Plate Sets
Final SE Testing
Through Resistance Test
Disassembly Corrosion Inspection
In Process

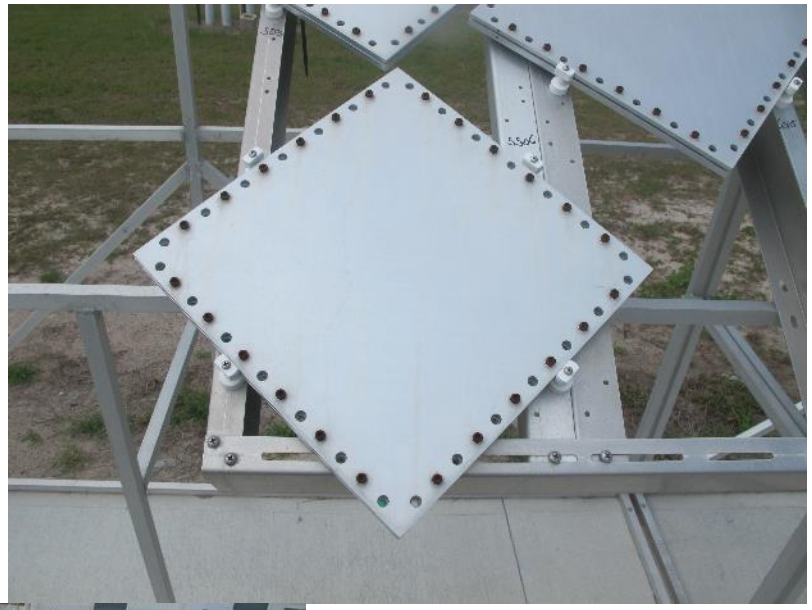
National Aeronautics and Space Administration (NASA)

KSC Beachfront Day One



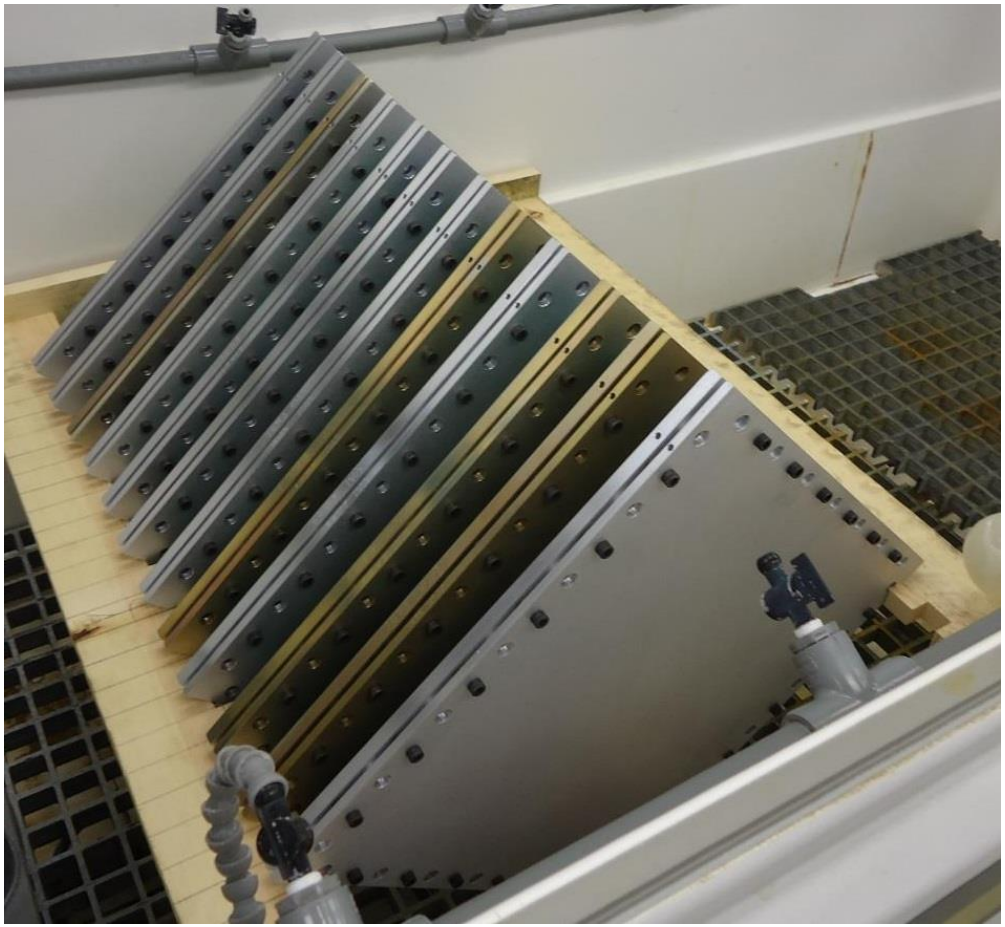


KSC Beachfront 3 Months



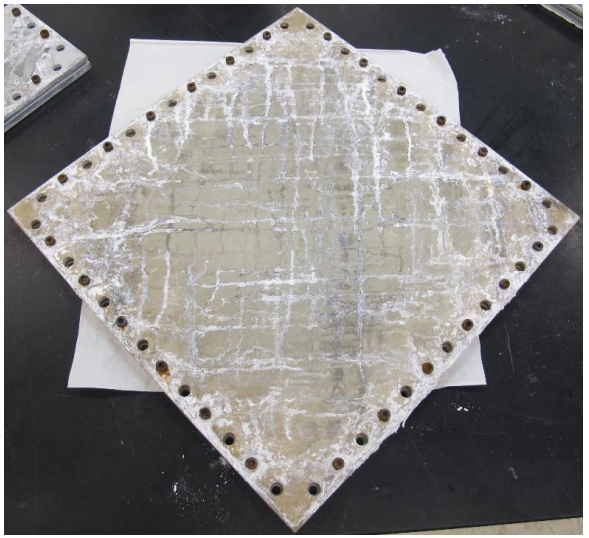
ASTM B 117 Salt Spray

Day One



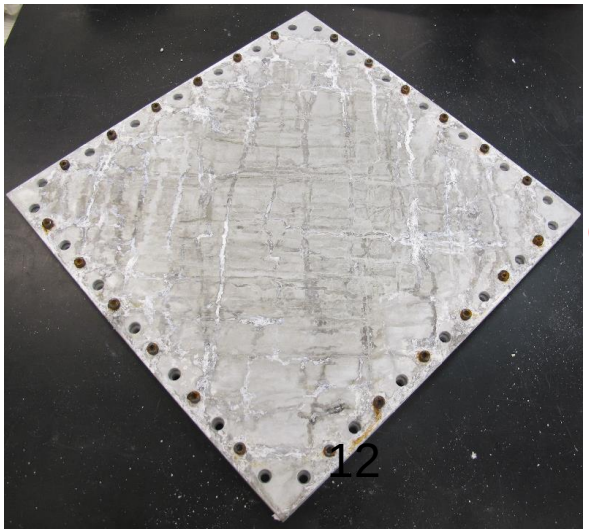
Week Six

5052-H32 – Alodine 1200S



No pitting observed

5052-H32 – SurTec 650



No pitting observed

Shielding Effectiveness Data

Chomerics test procedure

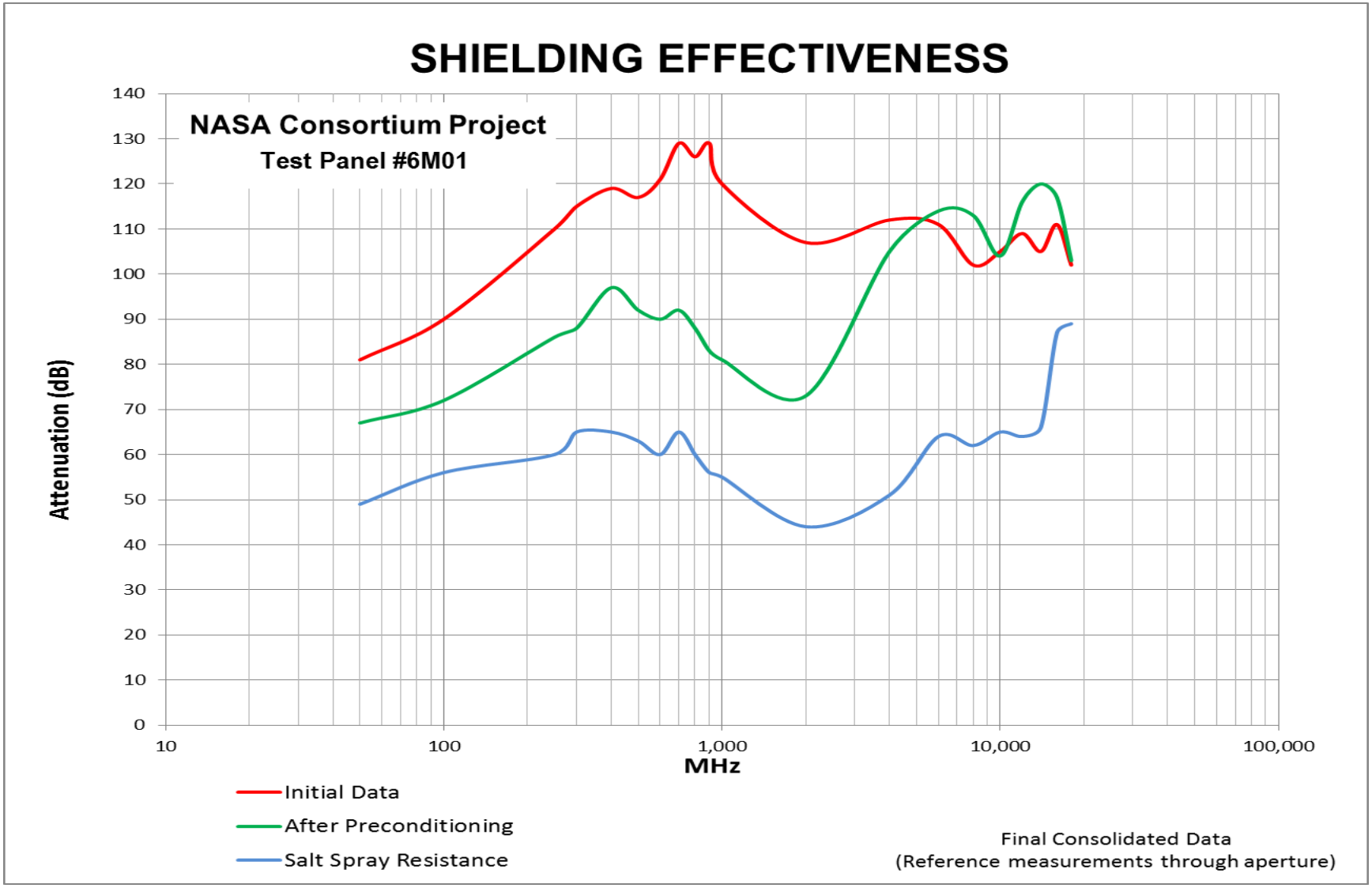
Test Procedure to Measure the Shielding Effectiveness Performance of EMI Gaskets Including Environmental Exposure

The environmental exposure can include temperature cycling, humidity cycling, and/or salt fog or any combination thereof. Exposure of conductive elastomer/mating flange combinations to harsh environmental conditions (e.g., corrosive, high temperature or fuel laden) may result in physical or electrical degradation of the conductive elastomer or mating flange or both which can lead to a loss in shielding effectiveness.

It is known that environmental testing causes a decrease in shielding effectiveness when hexavalent chrome pretreatments are used (Alodine 1200s), however, there is **no test data** for how shielding effectiveness is impacted when hexavalent chrome free pretreatments are used.

National Aeronautics and Space Administration (NASA)

Test Panel #6M01



National Aeronautics and Space Administration (NASA)

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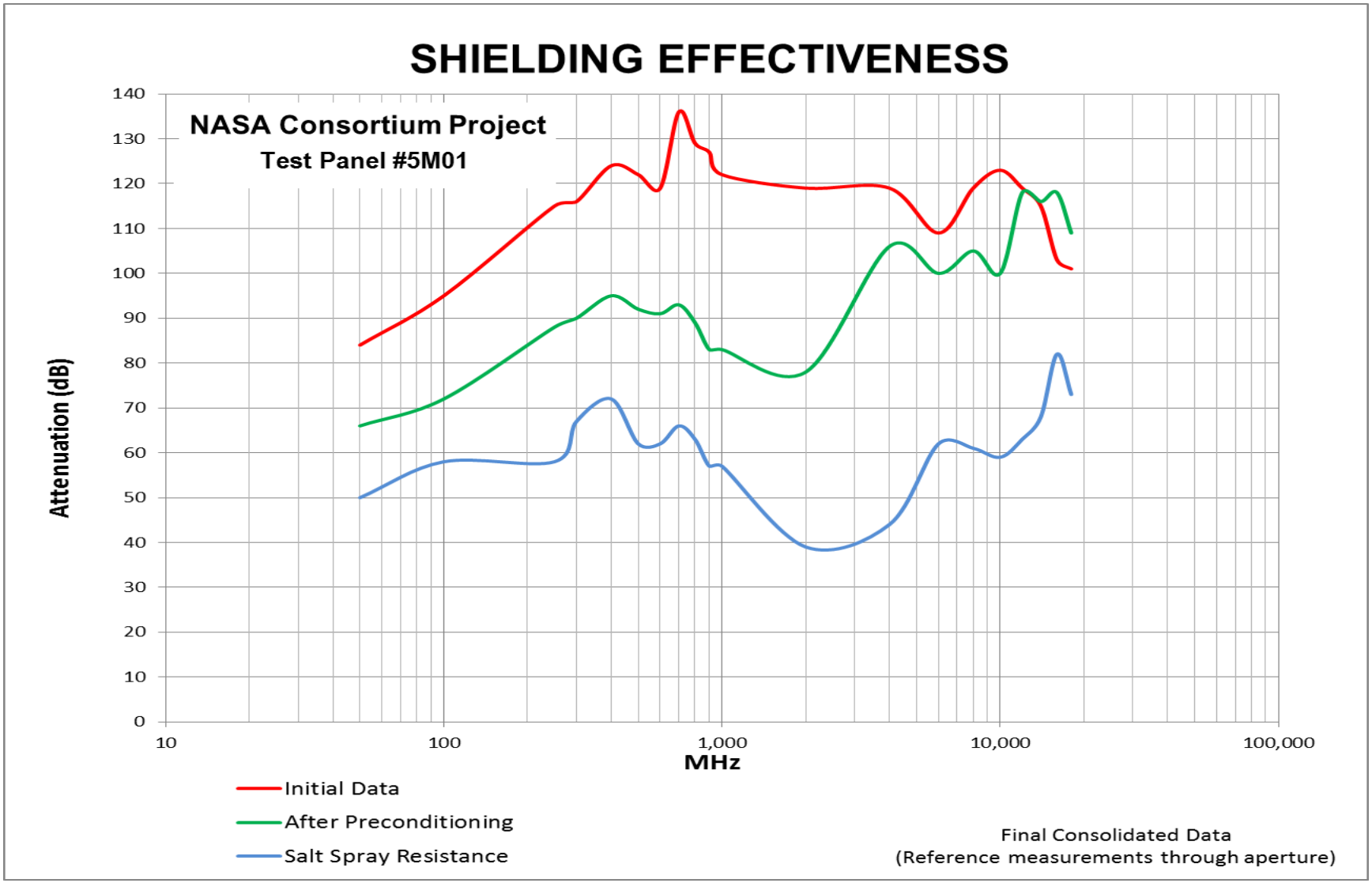

National Aeronautics and Space Administration (NASA)

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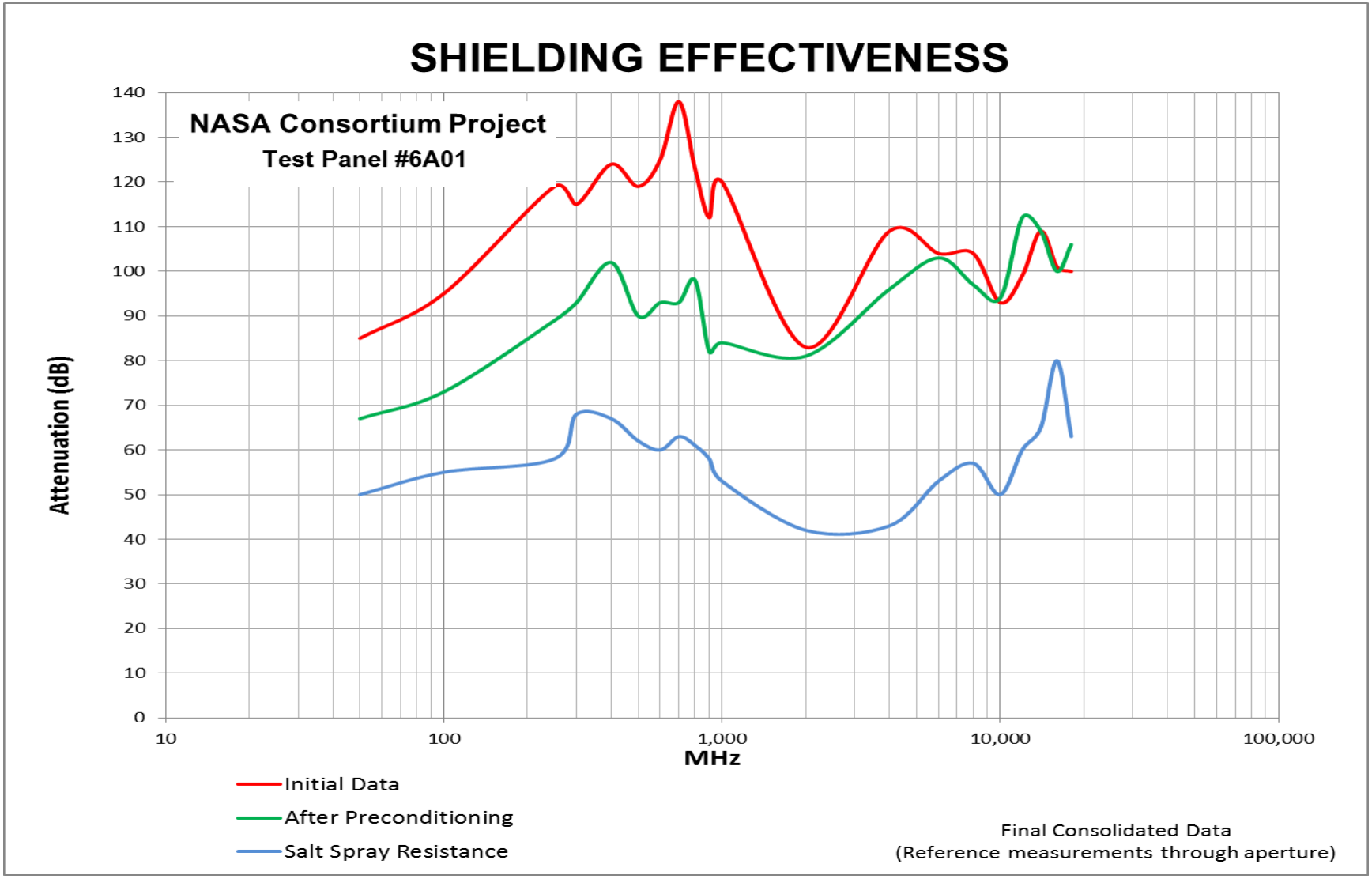
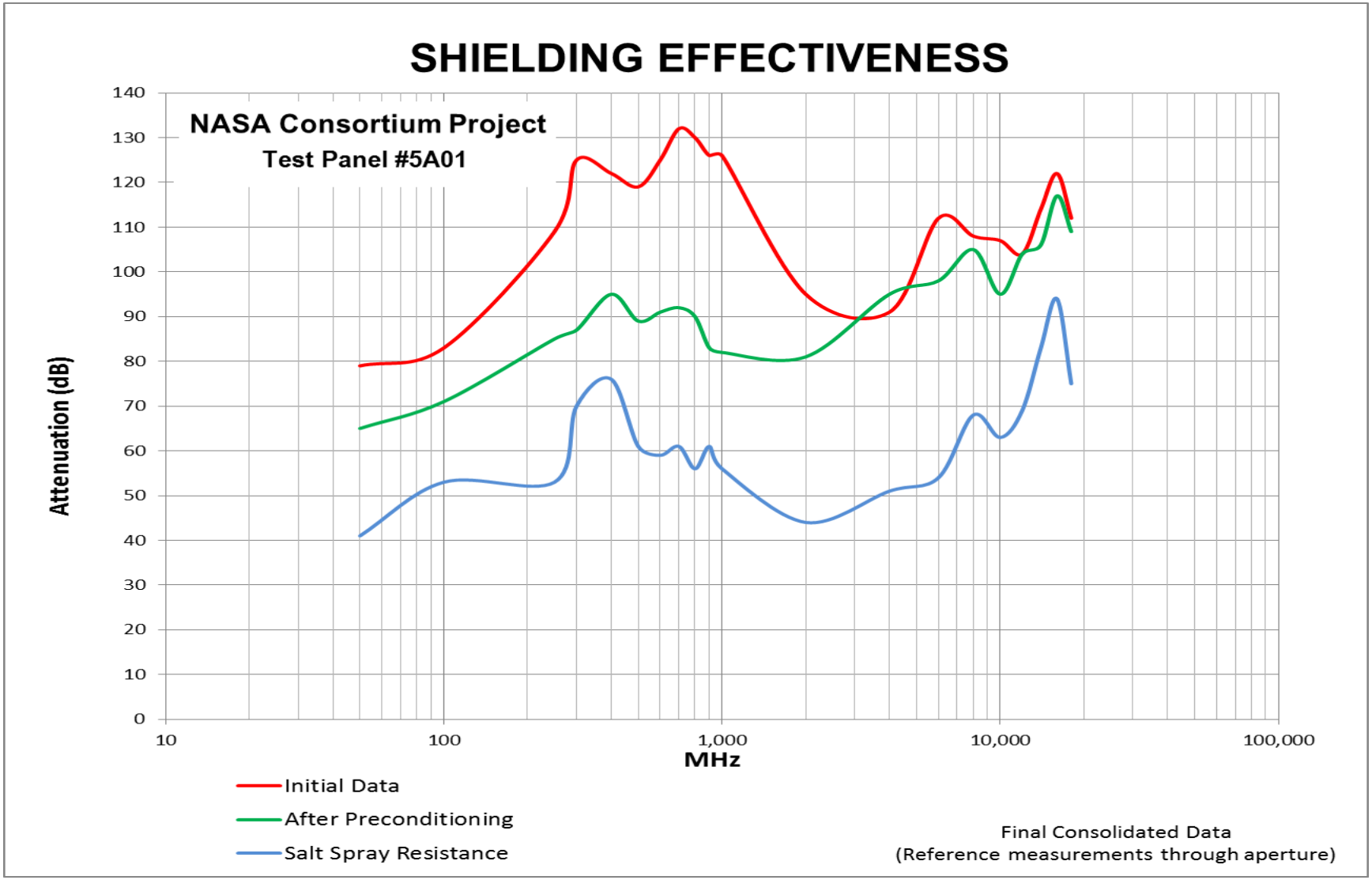


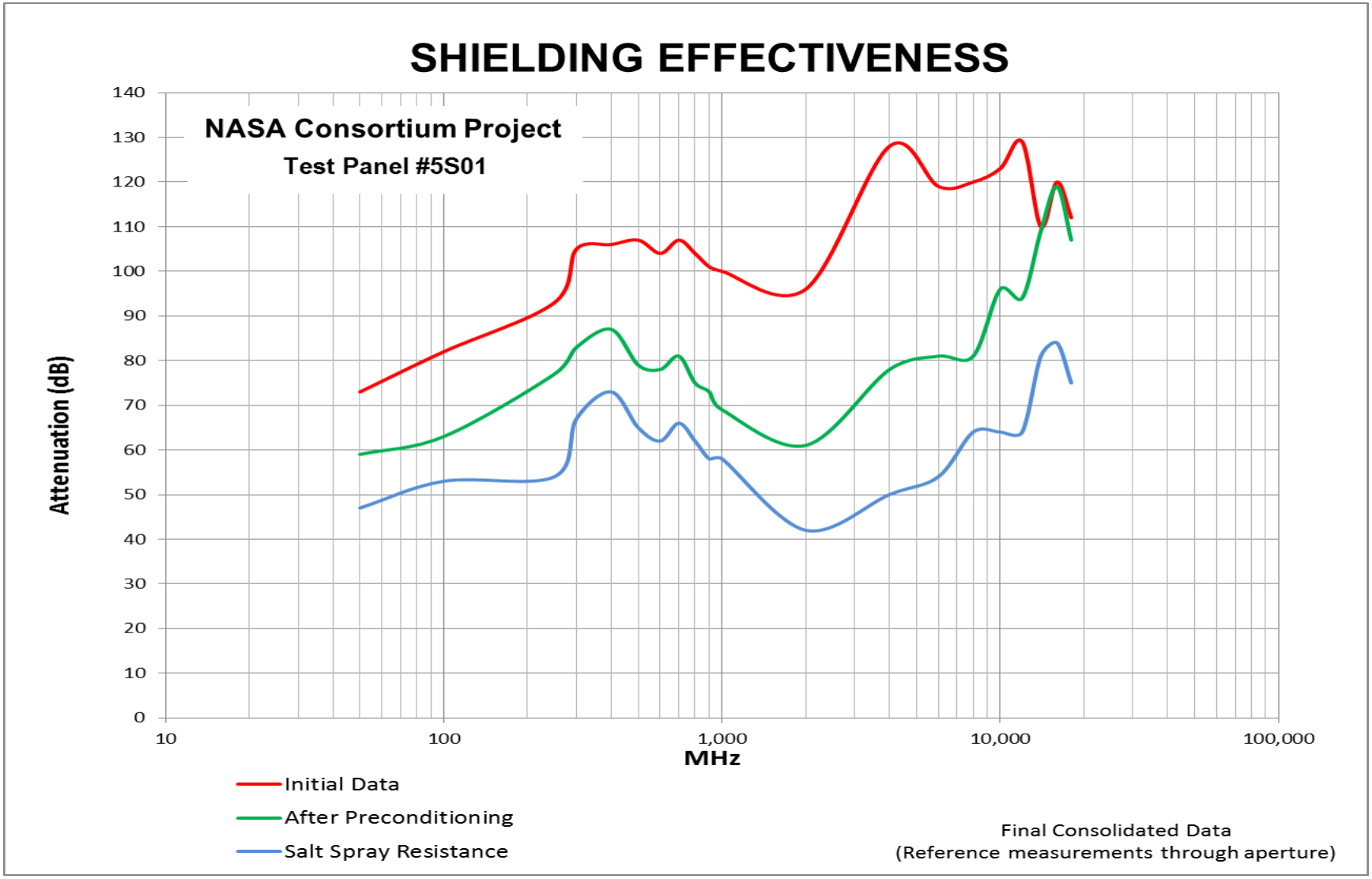
National Aeronautics and Space Administration (NASA)

Test Panel 5A01



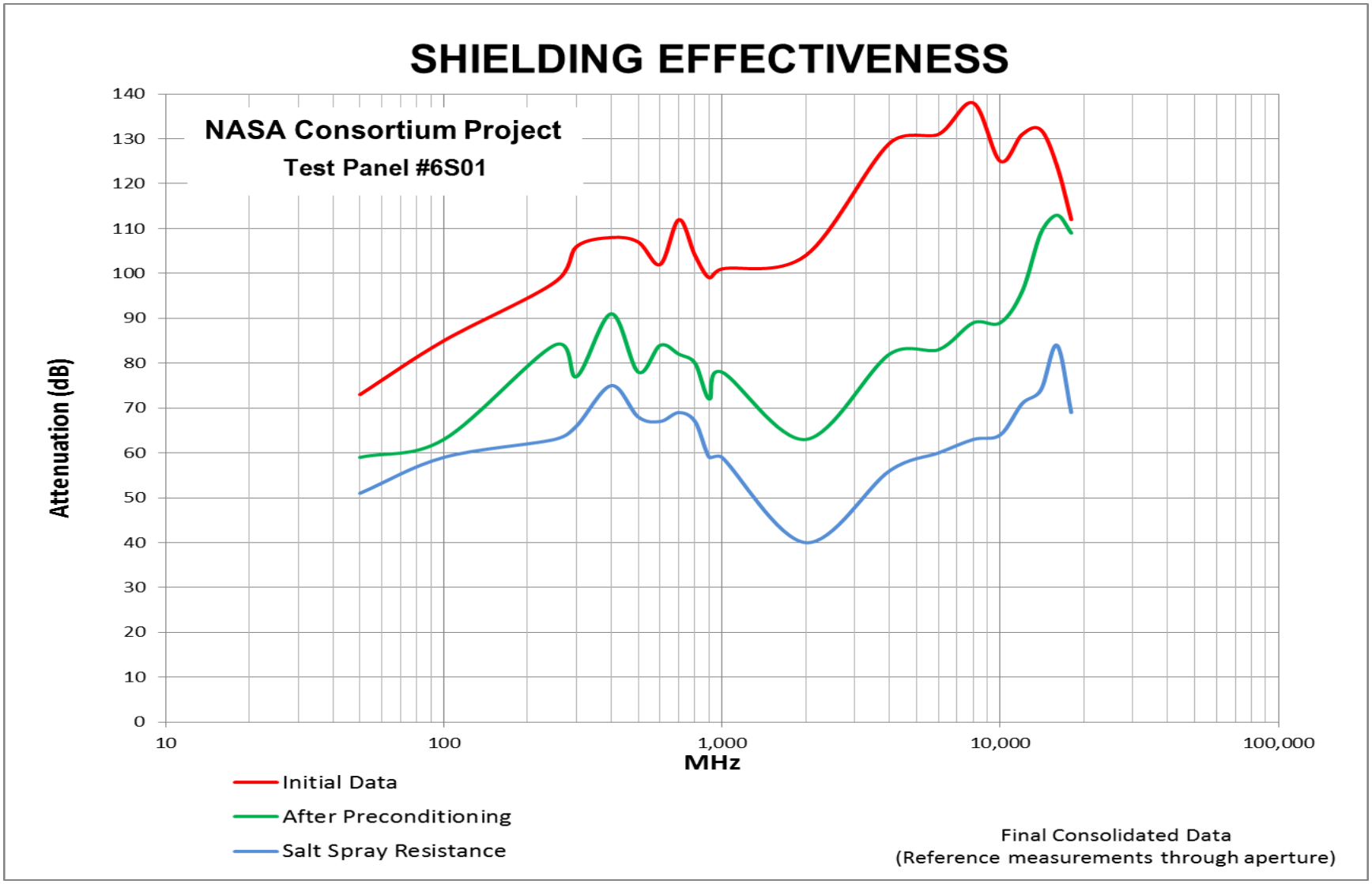
National Aeronautics and Space Administration (NASA)

Test Panel #5S01



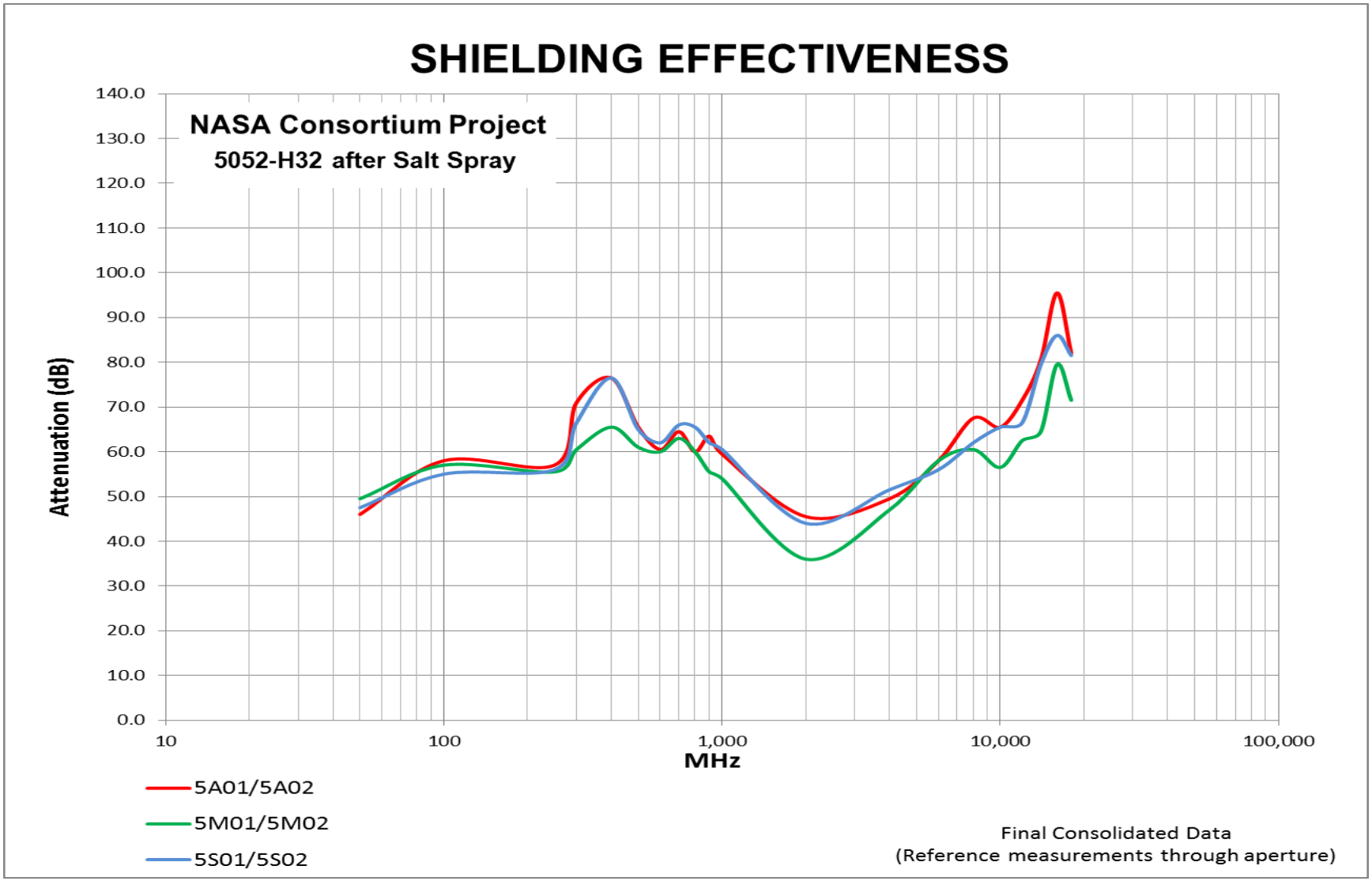
National Aeronautics and Space Administration (NASA)

Test Panel #6S01



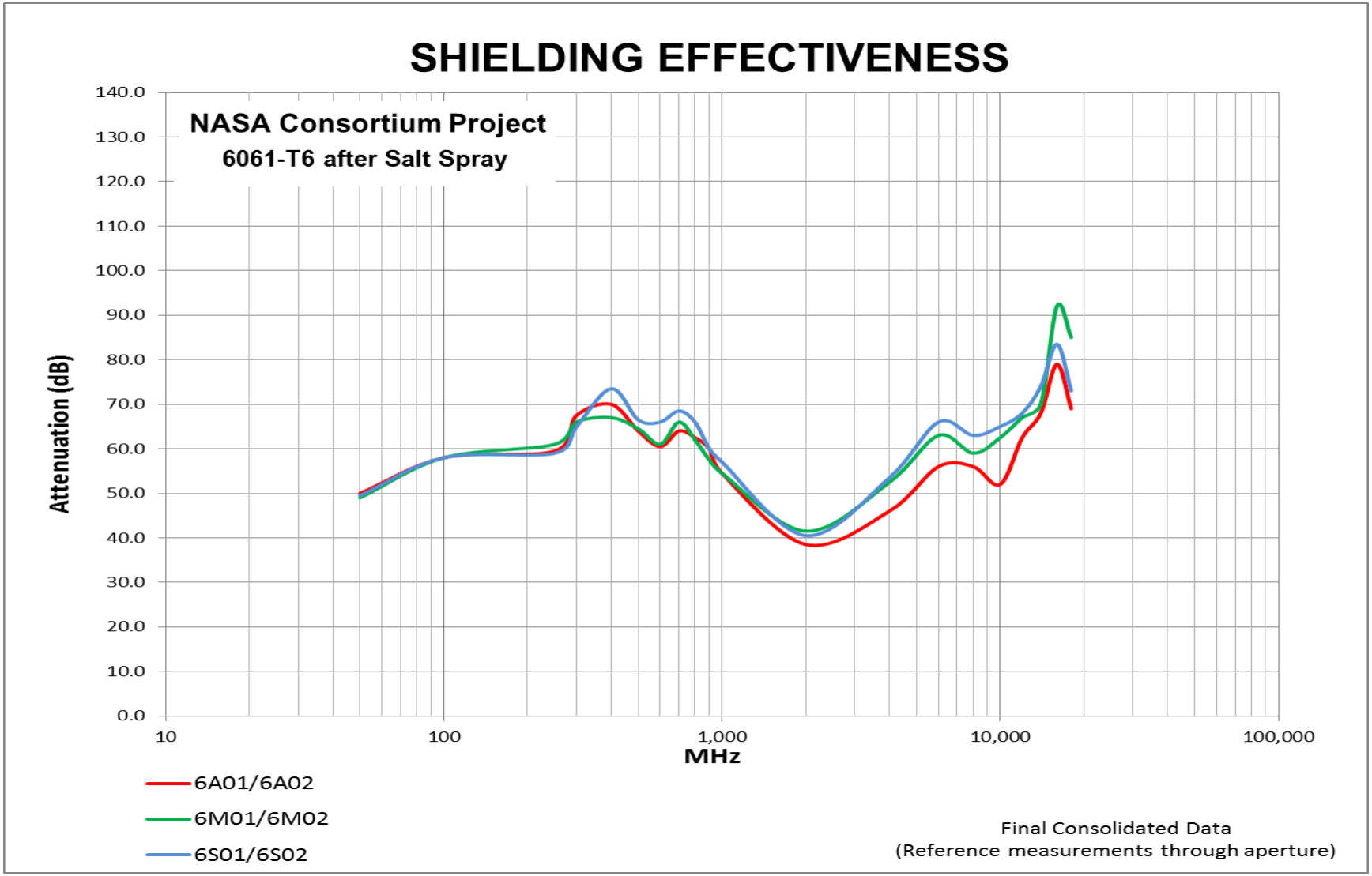
National Aeronautics and Space Administration (NASA)

Aluminum 5052-H32 – Consolidated After Salt Spray



National Aeronautics and Space Administration (NASA)

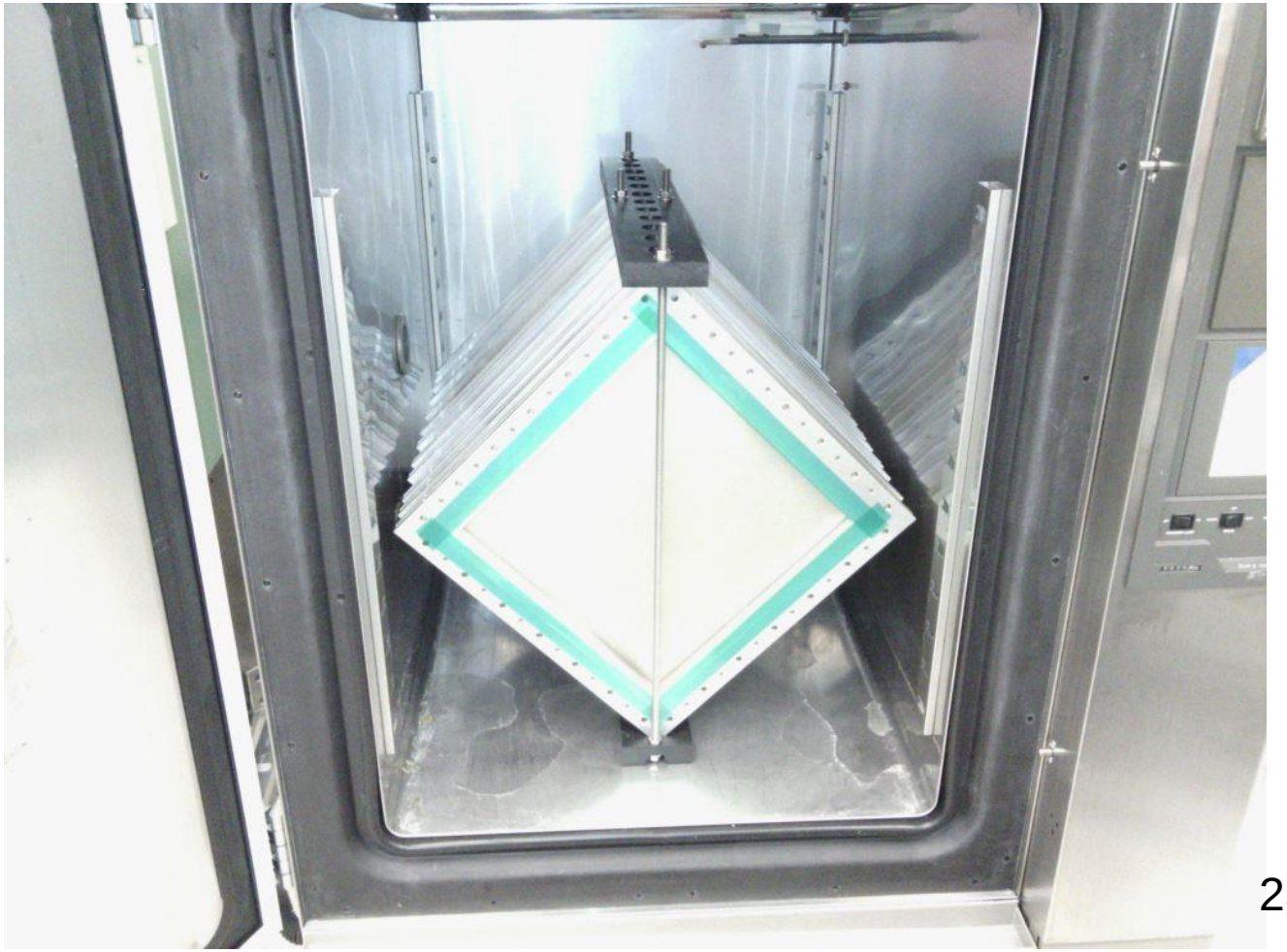
Aluminum 6061-T6 – Consolidated After Salt Spray



Static Heat and Humidity

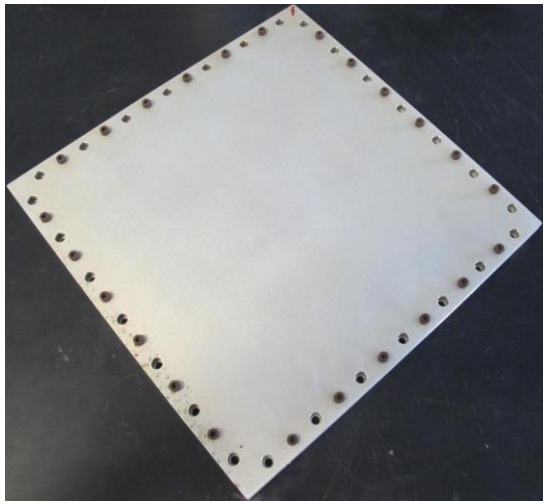
85°C +/- 1°C and 85% RH +/- 5% RH

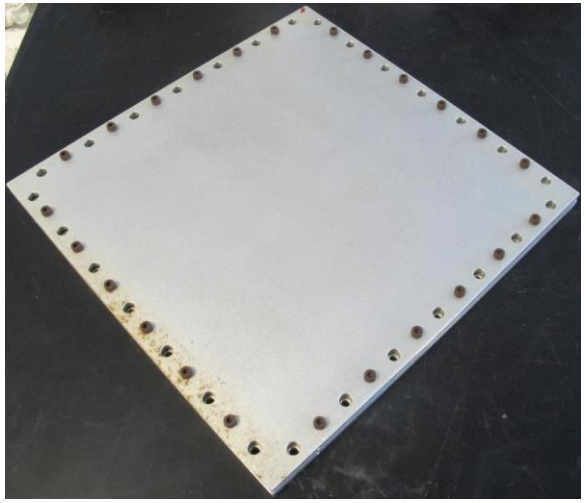
Day One



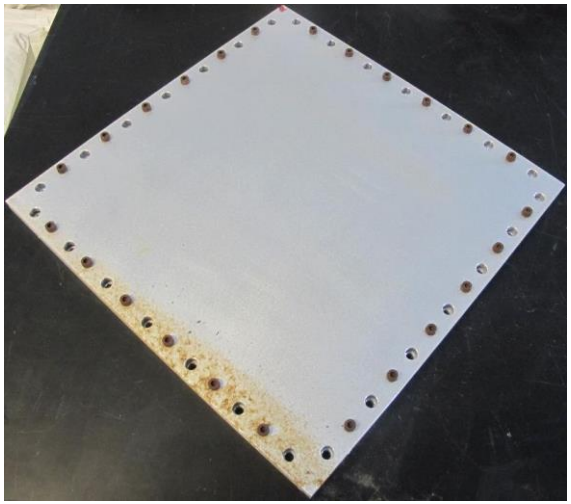
1,000 Hours of Exposure - 5052-H32

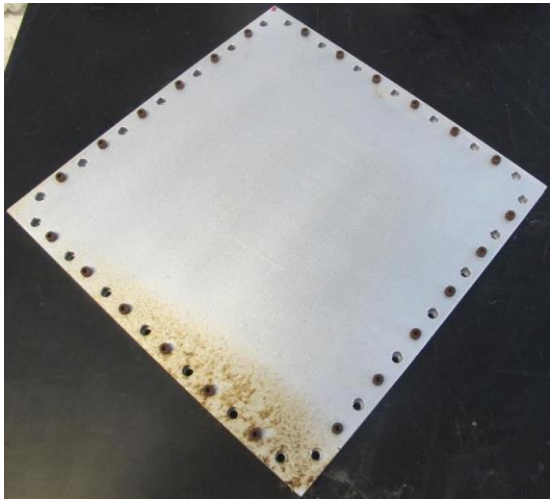
Alodine 1200S



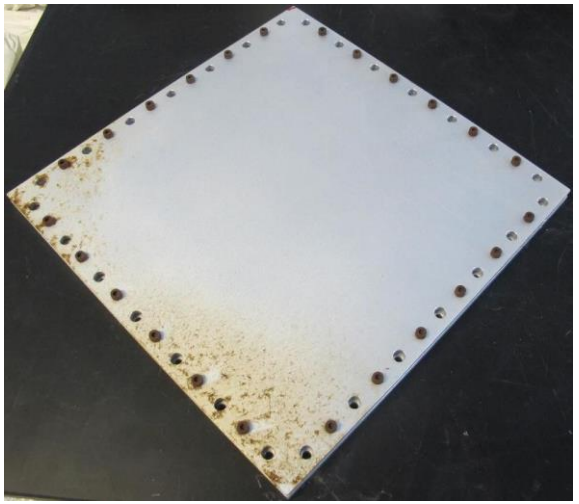


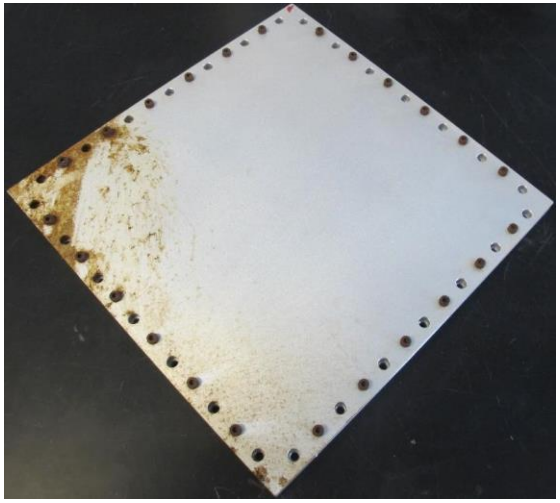
Metalast TCP-HF





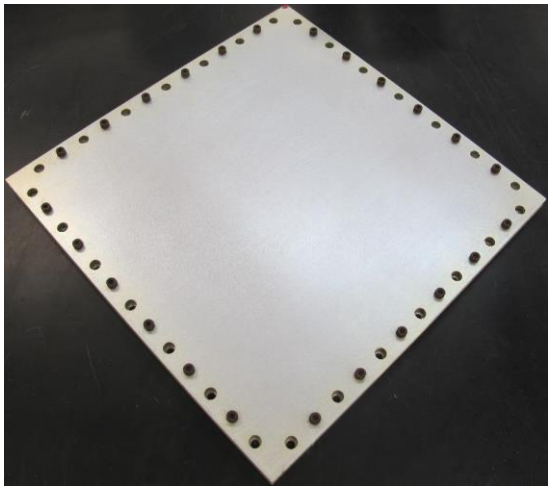
SurTec 650

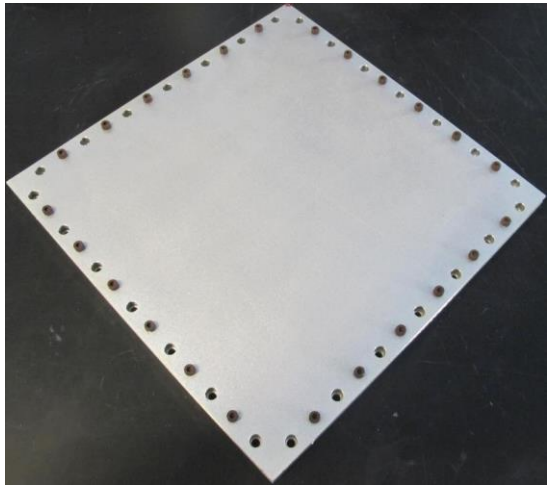




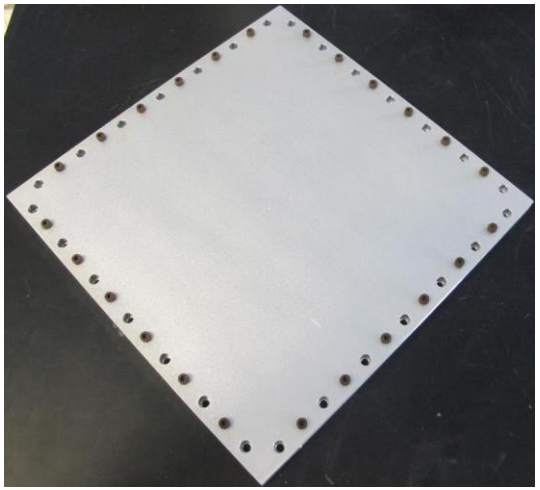
1,000 Hours of Exposure – 6061-T6

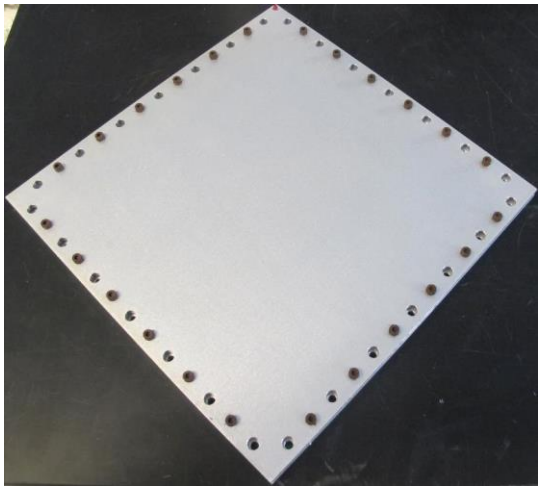
Alodine 1200S



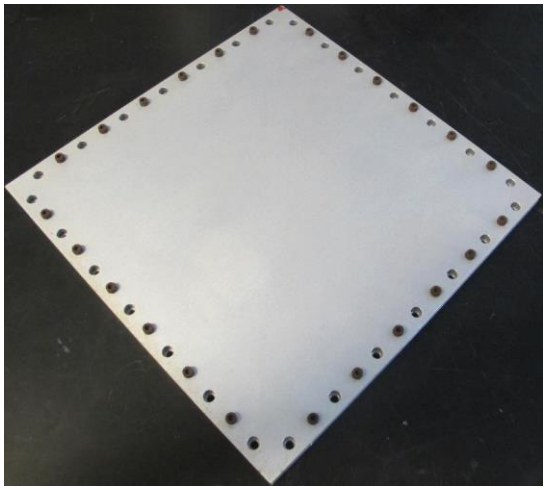


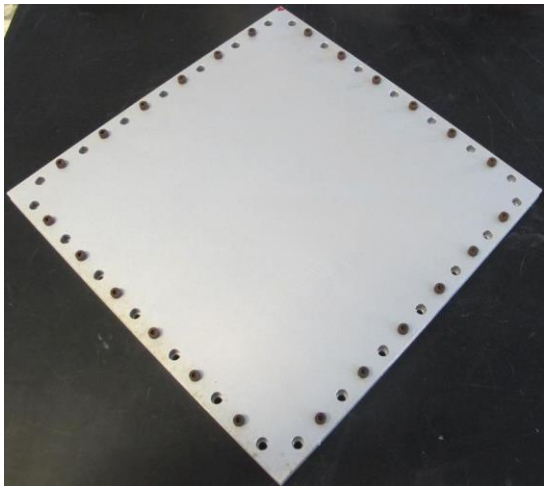
Metalast TCP-HF





SurTec 650

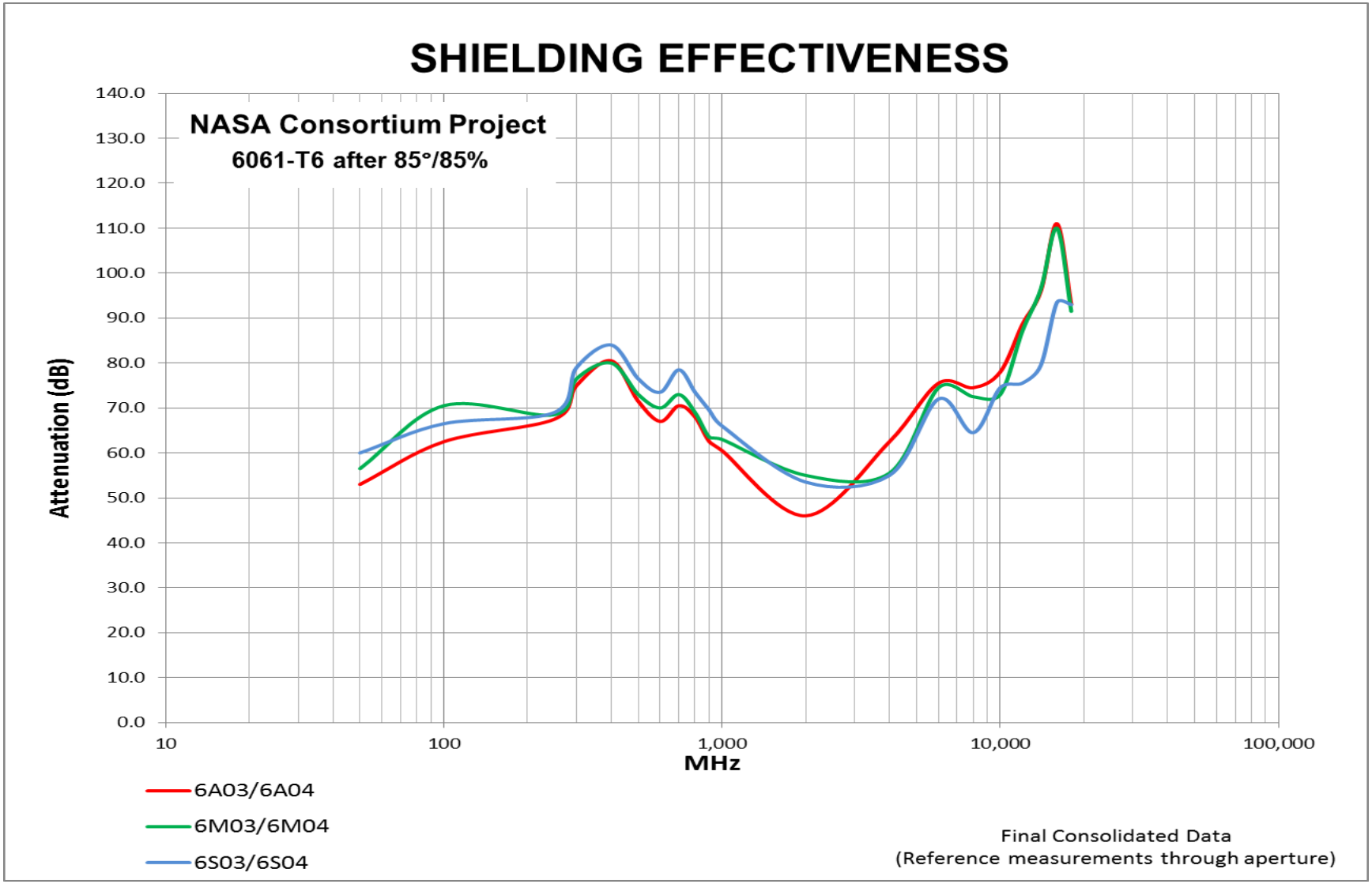




Shielding Effectiveness Data

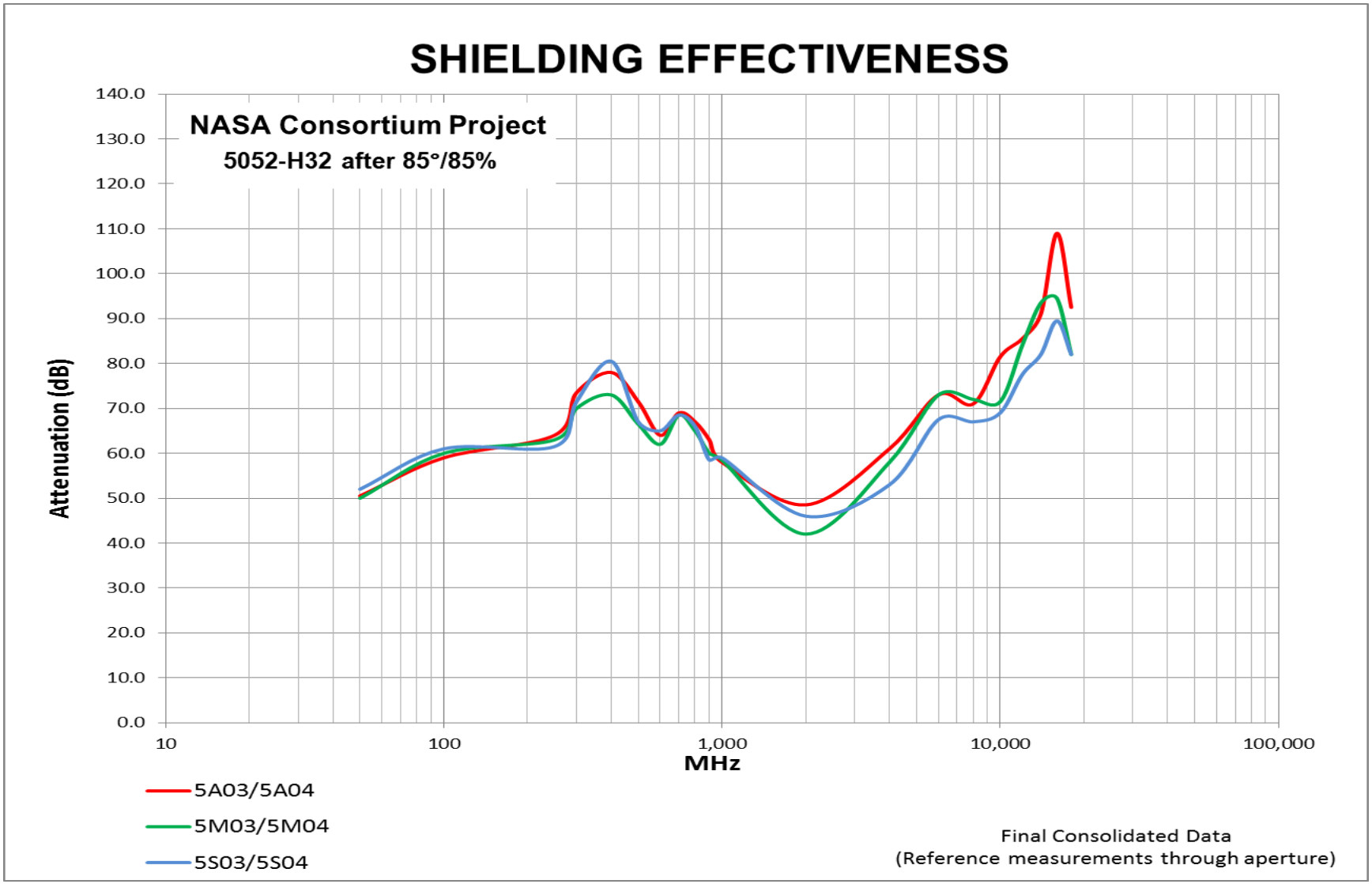
National Aeronautics and Space Administration (NASA)

Aluminum 6061-T6 – Consolidated
After 85/85 Temp/Humidity



National Aeronautics and Space Administration (NASA)

Aluminum 5052-H32 – Consolidated
After 85/85 Temp/Humidity



Next Phase

Evaluation of the Impact of Conversion Coatings on RF Transmission Loss (Northrop Grumman proposal)

- Design an experiment to assess impact of conversion coatings on RF transmission loss
- Test 3-foot sections of WR-28 waveguide to quantify impact to loss at Ka-band
  - Obtain test vehicles and coat them.
  - Measure RF transmission loss, as coated
  - Environmental Exposure
  - Measure RF transmission loss during/after environmental exposure