NATIONAL BUILDING SUPPLIES, LLC.

ULTRA NT SCIF Barrier – SOLID
Product Submittal

Toll free: (800) 753-9090
Website: ultrantscifbarrier.com

ULTRA NT SCIF Barrier - Solid RF Shielding Barrier is designed and has been tested for use in Sensitive Compartmented Information Facilities (SCIFs). ULTRA NT SCIF Barrier - Solid is engineered to provide enhanced security and protection for SCIF environments. It is designed to prevent the transmission of electromagnetic signals, sound, and physical vibrations that could potentially compromise the confidentiality of the information being handled within the SCIF.

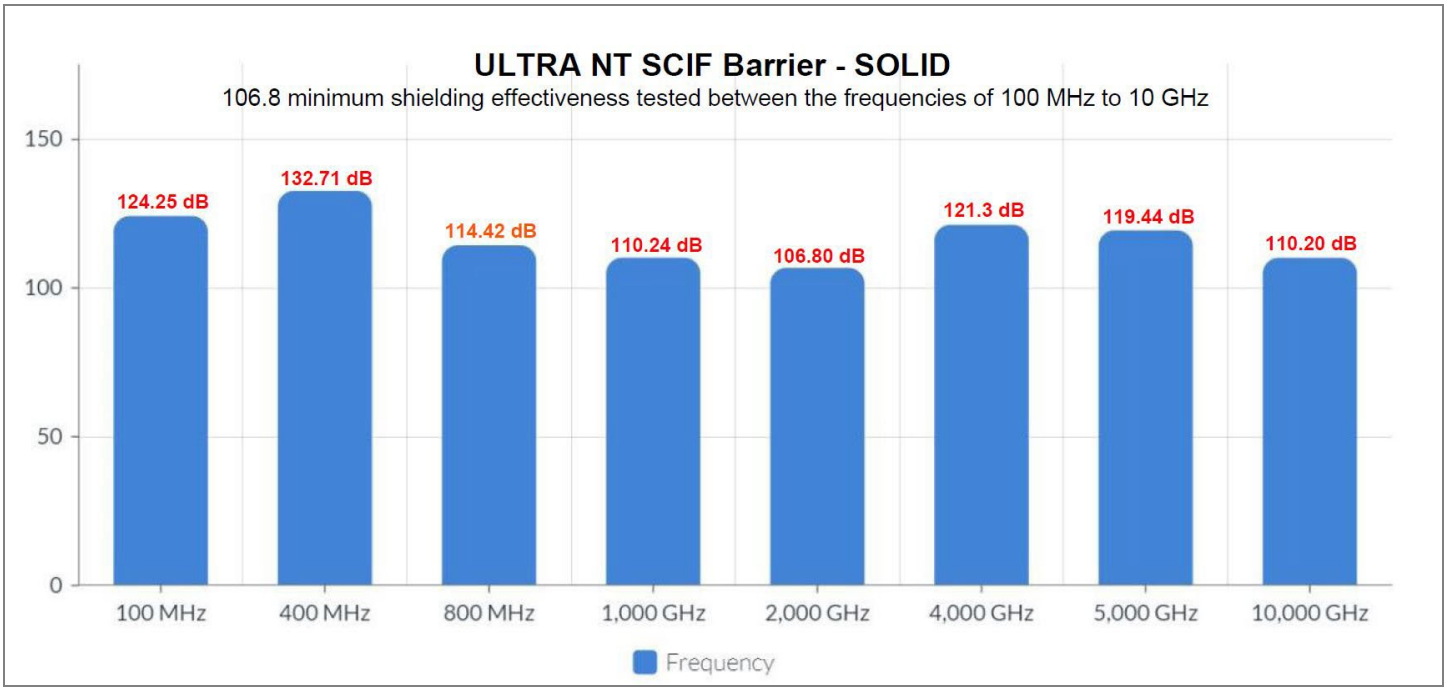
PRODUCT TESTING: ULTRA NT SCIF Barrier – SOLID product testing was performed at MET Laboratories, Inc., 914 West Patapsco Avenue, Baltimore, Maryland. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology. Testing was evaluated using IEEE-299 guidelines. The full comprehensive test report is included below.

Physical Properties	Test Standards	Aluminum Foil / Scrim / Aluminum Foil
106.8 minimum shielding effectiveness	IEEE-299	Tested between 100 MHz to 10 GHz.
91.7 minimum shielding effectiveness	IEEE-299	Tested between 30 MHz to 18 GHz.
Tensile Strength – CD	ASTM D882	52.6 lbs./inch
Temperature Range	ASTM C411	-60 F to 190 F (-51 C to 88 C)
Fire Rating	ASTM E84-10	Class 1 / Class A
Fire Rating	ASTM E84-10	Flame spread = 0 Smoke Development = 5
Pliability	ASTM C1313-07	No Cracking or Delamination
Permeability	ASTM E96-05	0.01 Perms
Resistance to Fungi & Bacteria	ASTM C-1338	Pass – No Growth
Emissivity	ASTM C-1371	0.03
Reflectivity	---	97%
Roll size	---	48” wide x 125’ long (500 square feet)
500 square foot roll weight = 16.75 lbs.	---	0.0335 per sq/ft or 0.000232 per sq/in
Tensile Strength – Tear Resistance	ASTM D882	Length: 16.75 lbs. / 500 feet = 0.0335 psf.
	ASTM D882	Width: 16.75 lbs. / (500/48) = 16.75 lbs. / 10.4167

NATIONAL BUILDING SUPPLIES, LLC.

ULTRA NT SCIF Barrier – SOLID
Product Submittal

Toll free: (800) 753-9090
Website: ultrantscifbarrier.com



106.8 minimum shielding effectiveness tested between the frequencies of 100 MHz to 10 GHz	
Frequency (MHz)	Minimum Shielding Effectiveness
100 MHz	124.25 dB
400 MHz	132.71 dB
800 MHz	114.42 dB
1,000 GHz	110.24 dB
2,000 GHz	106.80 dB
4,000 GHz	121.3 dB
5,000 GHz	119.44 dB
10,000 GHz	110.20 dB

PRODUCT TESTING: ULTRA NT SCIF Barrier – SOLID product testing was performed at MET Laboratories, Inc., 914 West Patapsco Avenue, Baltimore, Maryland. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology. Testing was evaluated using IEEE-299 guidelines. The full comprehensive test report is included below.

Toll free: (800) 753-9090
Website: ultrantscifbarrier.com

91.70 minimum shielding effectiveness tested between the frequencies of 30 MHz to 18 GHz	
Frequency (MHz)	Minimum Shielding Effectiveness
30.00 MHz	95.87 dB
31.30 MHz	96.23 dB
34.80 MHz	91.70 dB
38.30 MHz	95.25 dB
100 MHz	124.25 dB
400 MHz	132.71 dB
800 MHz	114.42 dB
1,000 GHz	110.24 dB
2,000 GHz	106.80 dB
4,000 GHz	121.3 dB
5,000 GHz	119.44 dB
10,000 GHz	110.20 dB
18,000 GHz	92.21 dB

PRODUCT TESTING: ULTRA NT SCIF Barrier – SOLID product testing was performed at MET Laboratories, Inc., 914 West Patapsco Avenue, Baltimore, Maryland. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology. Testing was evaluated using IEEE-299 guidelines. The full comprehensive test report is included below.

ULTRA NT SCIF Barrier – SOLID
Product Submittal

Toll free: (800) 753-9090
Website: ultrantscifbarrier.com

3M 1520-CW aluminum foil non-conductive tape is a nominal 2 mil high strength dead soft non-conductive aluminum foil coated tape with Venture's CW cold weather solvent acrylic pressure-sensitive adhesive. The malleable foil applies easily to both fibrous and sheet metal ducts and conforms to irregular surfaces. Venture Tape 1520CW excels in demanding temperature and humidity applications and provides superior performance and durability over a wide range of environmental conditions.

Available roll sizes
2" wide x 150' long
3" wide x 150' long
Note: Other widths maybe available by special order

3M™3302 Electrically Conductive Aluminum Tape is a 2.0 mil high strength dead soft aluminum foil coated with a conductive pressure sensitive acrylic adhesive. Good adhesion, malleability and adhesive conductivity allow for extremely low resistance and make this an excellent shielding tape.

Available roll sizes
2" wide x 108' long
4" wide x 108' long.
Note: Other widths maybe available by special order

3M™ 1170 EMI Aluminum Foil Shielding Tape is a 3-mil (0.076 mm) thick tape composed of a 2-mil (0.051 mm) flat aluminum foil backing coated on one side with a non-corrosive, electrically conductive acrylic pressure-sensitive adhesive supplied on removeable liner for easy handling.

Available roll sizes
1" wide x 54' long
2" wide x 54' long
Note: Other widths maybe available by special order

3M Super 77™ Multipurpose Spray Adhesive to be an extremely versatile, fast-drying spray adhesive that bonds a wide range of lightweight materials.

Available sizes
24 fluid ounce spray cans
Five-gallon pails
30 Pound Canisters

Ultra NT SCIF Barrier

General Installation Instructions

The suggested installation instructions for our ULTRA NT SCIF Barrier are detailed below. These installation instructions should never be allowed to override your job's specific architectural details and/or specifications. ULTRA NT SCIF Barrier is distributed by National Building Supplies, LLC. If you have questions, need to check product availability and pricing or if you need technical data sheets for any of our products, please call Michael Thrift on (800) 753-9090. You may also visit our website at www.ultrantscifbarrier.com

Section 1: How to measure and cut our ULTRA NT SCIF Barrier

1. Measure the surface area that needs to be covered with ULTRA NT SCIF Barrier then add 12 inches on each end or 24 inches overall to the length, because you must extend the ULTRA NT SCIF Barrier at the top of the wall onto the ceiling for 12 inches and also at the bottom of the wall onto the floor for 12" unless otherwise specified in the Architectural Specifications.

2. Here is an example, if your wall height measures 84 inches tall you must add an additional 24 inches to the overall length so you can extend the SCIF Barrier onto both the floor and ceiling for 12 inches, this would make your overall required length 108 inches.

3. Unroll the ULTRA NT SCIF Barrier onto a flat surface and measure the overall length required as detailed above then using a straight edge draw a straight line across the material then cut using a utility knife or scissors.

Section 2: How to measure, cut and install ULTRA NT SCIF Barrier in between two layers of drywall.

1. Install your first layer of drywall onto your studs following all the architectural specifications and details for your specific job.

2. Measure the surface area that needs to be covered with ULTRA NT SCIF Barrier then add 12 inches on each end or 24 inches overall to the length, because you must extend the ULTRA NT SCIF Barrier at the top of the wall onto the ceiling for 12 inches on also at the bottom of the wall onto the floor for 12" unless otherwise specified in the Architectural Specifications.

3. Here is an example, if your wall height is 84 inches tall you must add an additional 24 inches extend the SCIF Barrier onto both the floor and ceiling for 12 inches, this would make your overall required length 108 inches.

4. Unroll the ULTRA NT SCIF Barrier onto a flat surface and measure the overall required length as detailed above then using a straight edge draw a straight line across the material then cut using a utility knife or scissors.

5. You have the option to make your 12-inch fold on the top and bottom section of your pre-cut ULTRA SCIF Barrier while it is still laying on your flat surface. This helps speed up and make a cleaner-looking installation.

6. Install your first layer of ULTRA NT SCIF Barrier onto your drywall temporarily holding it in place with staples or 3M Super 77 general-purpose construction adhesive which is available in 24 fluid ounce spray cans or in five-gallon pails for larger areas.

    - One option when you are applying 3M Super 77 General purpose construction adhesive for larger areas to drywall is using an inexpensive adjustable paint sprayer.

7. As you are applying the ULTRA NT SCIF Barrier to your first layer of drywall remember that you must sure overlap all your side to side seem by six inches. Then you must tape all the seams using the tape that is specified in the architectural specifications and details for your project. Note: the most used tapes are shown below in section 3.

8. After you have the ULTRA NT SCIF Barrier in place, and you have followed each step on your specified in the architectural specifications and details for your project. You can install your second layer of gypsum board on top of the ULTRA NT SCIF Barrier. The Manufacturer recommends using black phosphate fine thread drywall screws when installing your drywall unless otherwise specified in the Architectural Specifications.

Section 3: Tapes:

These are the most used tapes that our customers order when they are installing our ULTRA NT SCIF Barrier. These commonly used tapes should never override the architectural specifications and details for your specific job. The technical data sheets for all the tapes shown above are available upon request by calling Michael Thrift at (800) 753-9090 or by visiting our website: www.ultrantscifbarrier.com.

3M 1520-CW aluminum foil non-conductive tape is a nominal 2 mil high strength dead soft non-conductive aluminum foil coated tape with Venture's CW cold weather solvent acrylic pressure-sensitive adhesive. The malleable foil applies easily to both fibrous and sheet metal ducts and conforms to irregular surfaces. Venture Tape 1520CW excels in demanding temperature and humidity applications and provides superior performance and durability over a wide range of environmental conditions.

- 2" wide x 150' long
- 3" wide x 150' long

3M™ 3302 Conductive Aluminum Foil Tape is a high-strength, dead soft aluminum foil-coated tape with a specially formulated conductive pressure-sensitive acrylic adhesive system. The tape features good adhesion, malleability, and adhesive conductivity to allow for extremely low resistance and to make this an excellent shielding tape for EMI and RF shielding applications in the electronics industry.

- 2" wide x 108' long
- 4" wide x 108' long
- 8" wide x 108' long

3M™ 1170 Conductive Aluminum Foil Tape is a 3-mil (0.076 mm) thick tape composed of a 2-mil (0.051 mm) flat aluminum foil backing coated on one side with a non-corrosive, electrically conductive acrylic pressure-sensitive adhesive supplied on a removable liner for easy handling.

- 1" wide x 54' long
- 2" wide x 54' long
- 3" wide x 54' long

Section 4: Commonly used Adhesive

3M™ Super 77™ Multipurpose Construction Adhesive is an extremely versatile, fast-drying spray adhesive that bonds a wide range of lightweight materials. Our permanent bond provides fast results to keep projects moving ahead. The photo-safe spray formula is easy to dispense and apply directly onto surfaces and materials where needed, with no soak-in or yellowing over time.

- 24 Fluid ounce spray cans
- Five-gallon pails (The estimated coverage is shown below)

One option when you are applying 3M Super 77 General purpose construction adhesive for larger areas to drywall is using an inexpensive adjustable paint sprayer.

The estimated coverage per five-gallon pail applied at .5 grams per square foot is 12,000 square feet and the estimated coverage per five-gallon pail applied at 1 gram per square foot is 6,000 square feet.

Section 4: How to prepare your concrete floor before installing your ULTRA NT SCIF Barrier

1. Make sure that the concrete surface is as clean and dust free before beginning the installation of the ULTRA NT SCIF Barrier
2. Make sure there are no jagged areas on your concrete floor that could cut into the ULTRA NT SCIF Barrier during the installation.
3. Be sure to fill any cracks and or holes in your concrete with a concrete patching material before installing the ULTRA NT SCIF Barrier

Section 5: How to install ULTRA NT SCIF Barrier to your concrete slab.

If you want to install Ultra-NT SCIF Barrier onto your concrete floor using 3M Super 77 Construction Adhesive, here are the steps you can follow:

1. Prepare the concrete floor: The concrete floor must be clean, dry, and free of any debris. Any unevenness or cracks in the surface of the concrete should be addressed before installing the barrier.

2. Cut the barrier to size: Measure the dimensions of the area that needs to be covered and cut the Ultra-NT SCIF Barrier to size using a utility knife.

1. Option 1: Spray the adhesive: Apply 3M Super 77 Construction Adhesive to the back of the Ultra-NT SCIF Barrier in a thin, even layer. Be sure to apply the adhesive to all edges and corners of the barrier.

2. Option 2: Apply the 3M Super 77 Construction Adhesive to your concrete using a paint roller that is designed for painting concrete rolling the adhesive in a smooth layer at approximately 1 gram per square foot, each five-gallon pail of 3M Super 77 Multipurpose Adhesive will cover approximately 6,000 square feet when applied at 1 gram per square foot.

3. Apply the barrier: Carefully align the Ultra-NT SCIF Barrier with the area of the concrete floor you want to cover and press it firmly into place. Use a hand roller or weighted roller to roll the barrier onto the concrete floor. This will help ensure that the adhesive makes good contact with the concrete surface and that the barrier is installed evenly.

4. Secure the edges: Use conductive adhesive tape or a conductive caulk to seal the edges of the barrier and ensure that there are no gaps where RF signals can leak through.

5. Test the barrier: Once the Ultra-NT SCIF Barrier is installed, you should test it to make sure that it is effective in blocking RF signals. This can be done using specialized testing equipment.

It is important to note that the installation of Ultra-NT SCIF Barrier can be complex and may require specialized knowledge and expertise. It is recommended that you consult with an experienced professional who can help you determine the best way to install the barrier and ensure that it is installed correctly.

ULTRA NT SCIF Barrier is distributed by National Building Supplies, LLC. If you have questions, need to check product availability and pricing or if you need technical data sheets, please call Michael Thrift at (800) 753-9090. You may also visit our website at www.ultrantscifbarrier.com

August 14, 2018

National Building Supplies, LLC.
303 North Staduim Blvd Suite 200
Columbia, Missouri 65203
Toll free: (800) 753-9090
Website: ULTRANTSCIFBarrier.com

Dear Michael Thrift,

Enclosed is the EME Test Report for evaluating the shielding effectiveness of test samples supplied by ULTRA NT SCIF Barrier using IEEE-299 Shielding Effectiveness test techniques.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Michelle Tawmging
Documentation Department

Reference: (EMC96978-IEEE Rev. 3)

DOC-EMC1305 3/19/2007

Electromagnetic Effects (EME)
Test Report

for the

www.ULTRANTSCIFBarrier.com
ULTRA NT SCIF Barrier

To be evaluated using
IEEE-299
As a guideline

MET Report: EMC96978-IEEE Rev. 3

August 14, 2018

Prepared For:

www.ULTRANTSCIFBarrier.com
2000 East Broadway Suite 225 Columbia,
Missouri 65203

Prepared By:
MET Laboratories, Inc.
914 W. Patapsco Avenue
Baltimore, MD 21230

Electromagnetic Effects (EME)
Test Report

for the

www.ULTRANTSCIFBarrier.com
ULTRA NT SCIF Barrier

To be evaluated using techniques under
IEEE-299

Testing Performed By:

Long Ton
Electromagnetic Compatibility Lab

Report Prepared By:

Michelle Tawmging
Documentation Department

Ujwal Rai
Military Testing Manager, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	February 9, 2018	Initial Issue
1	February 14, 2018	Implemented Customer-Requested Revisions
2	February 19, 2018	Updated Chart 3
3	August 14, 2018	Updated Product Name from “ULTRA SCIF Barrier” to “ULTRA NT SCIF Barrier” and “ultrascifbarrier.com” to “ultrantscifbarrier.com”; Updated Chart 1 and Chart 2

Table of Contents

List of Charts

List of Figures

List of Photographs

List of Tables

List of Terms and Abbreviations

The following abbreviations may be referenced within this report.

dB	**d**eci**b**els
dB□V	**d**eci**b**els above one **micro-v**olt
cm	**c**enti**m**eter
EME	**E**lectro **M**agnetic **E**ffects
EMITP	**E**lectro **M**agnetic **I**nterference **T**est **P**lan
EMITR	**E**lectro **M**agnetic **I**nterference **T**est **R**eport
EUT	**E**quipment **U**nder **T**est
FO	**F**iber **O**ptic
G	**G**iga
H/V	**H**orizontal/**V**ertical
Hz	**H**ert**z**
in	**in**ch
kHz	**k**ilo**h**ert**z**
m	**m**eter
MHz	**M**ega**h**ertz
SE	**S**hielding **E**ffectiveness
W	**W**att
Ω	Ohm

I. EUT Configuration

A. Overview

Tests to examine multiple metallic impregnated paper test samples for ULTRA NT SCIF Barrier for the purpose of determining the overall shielding effectiveness, using IEEE-299 Shielding Effectiveness test techniques as a guideline for this evaluation.

Test Sample(s) Tested:	22x22 " ULTRA NT SCIF Barrier
Analysis:	The results obtained relate only to the item(s) tested.
Evaluated by:	Long Ton
Test Conditions:	Frequency Range from 10KHz to 18GHz on 22"x 22" Foil Sheet
Prepared by:	Michelle Tawmging

B. Test Criteria

Shielding Effectiveness of the EUT, for the purpose of this test, is the difference, expressed in decibels (dB), of the received RF field strength (in dBµV/m) when the receive antenna is illuminated by electromagnetic energy in the test equipment calibration configuration (Direct) and compared to a received RF field strength (in dBµV/m) through an electromagnetic barrier in the test measurements configuration (Indirect). The difference between the Direct (in dBµV) and the Indirect (in dBµV) is the SE as detailed in the following equation:

SE (in dB) = Direct (in dBµV/m) – Indirect (in dBµV/m)

Antenna Factors, cable loss and other test equipment attenuation are normalized out of the equation above, and therefore, do not need to be accounted for.

C. Test Site

All testing shall be performed at MET Laboratories, Inc., 914 W. Patapsco Avenue, Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

D. Description of Test Sample

The ULTRA NT SCIF Barrier, Equipment under Test (EUT) is a foil sheet.

E. Purpose of Test

The purpose of the test contained within is to obtain shielding effectiveness attenuation values (in dB) of multiple metal coated tent fabric materials to document the electromagnetic spectrum attenuation properties for mobile electromagnetically shielded enclosure construction.

F. Disposition of Test Sample

After testing is complete, the test samples will be returned to:

www.ULTRANTSCIFBarrier.com
2000 East Broadway Suite 225
Columbia, Missouri 65201

G. References

IEEE-299:2006	IEEE Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures: 15 September 2006
MIL-STD-45662A	Calibration System Requirements
ISO/IEC 17025: 2005	General Requirements for the Competence of Testing and Calibration Laboratories

Table 1. List of Reference Documents

G. List of Required Tests

IEEE-299	DESCRIPTION
5.2	Electromagnetic Shielding Effectiveness

Table 2. List of Tests Performed

H. Modifications to EUT, Standard Limits, and Test Frequencies

Prior to testing, all modifications to the EUT, standard limits, or test frequencies will be identified and agreed upon by the customer and the test laboratory.

Due to the test sample RF uniformity properties, only vertical transmit and receive antenna polarity was evaluated.

Electric field generating/receive test antennas were used. No loop antenna were used as IEEE-299 references within the desired frequency range as more interest in the electric field attenuation of the test samples were desired.

Transmit and Receive antenna distances specified in the IEEE-299 base standard specified 2.0m separation distances; one meter distance from the bulkhead to the test antenna on each side of the bulkhead. Closer distances, maintaining relative comparison, will be determined on a case-by-case basis.

Additionally, the Federal Communications Commission (FCC) prohibits intentional transmission within RF Communication Broadcast Bands.

I. General Test Setup Requirements

Shielding Effectiveness testing on the metal coated tent fabric samples occurred at MET Laboratories located in Baltimore, Maryland 21230. Prior to testing, an RF shielded enclosure utilized for the purposes of EME testing was verified to *IEEE-STD-299* specification for shielding effectiveness. Installation of a EUT bulkhead panel outer ring, conforming to the mounting-hole pattern of the test chamber bulkhead flange, was used to install the test sample against the test chamber bulkhead opening. Verification of chamber shielding effectiveness integrity identified in **Table 3** was made with a blank bulkhead panel installed to assure accurate base-line shielding effectiveness of the test chamber.

Each EUT metallic test sample was mounted to the chambers bulkhead in a manner to assure conductive EMI free path with a Test Chamber shielding effectiveness of at least 70dB at 13.56MHz, and at least 100dB from 30 MHz to 1 GHz.

J. Test Limits

The EUT (test sample) must meet the minimum performance attenuation requirements specified at discrete frequencies identified below:

Magnetic: 10KHz, 150kHz and 15MHz, Electric:
31.3MHz, 34.8MHz, 38.3MHz, 100MHz, 400MHz, 800MHz, 1GHz, 2GHz, 4GHz, 5GHz, 10GHz and 18GHz
Both Polarities of Test Antennas

Table 1—Standard measurement frequencies

Standard frequency	Antenna type	Clause procedure
Low range [a]		
9 kHz–16 kHz	Small loop	5.6
140 kHz–160 kHz	⇓	⇓
14 MHz–16 MHz	⇓	⇓
Resonant range [a]		
20 MHz–100 MHz	Biconical	5.7
100 MHz–300 MHz	Dipole	⇓
High range [b]		
0.3 GHz–0.6 GHz	Dipole	5.8
0.6 GHz–1.0 GHz	⇓	⇓
1.0 GHz–2.0 GHz	Horn	⇓
2.0 GHz–4.0 GHz	⇓	⇓
4.0 GHz–8.0 GHz	⇓	⇓
8.0 GHz–18 GHz	⇓	⇓

[a] Actual test frequencies shall be according to the approved test plan.
[b] A single frequency in each band is recommended, but actual test frequencies shall be according to the approved test plan.

Table 3. Standard Measurement Frequencies

II. Shielding Effectiveness

A. SE Shielding Effectiveness, Discrete Frequencies

Requirements: RF Attenuation (in dB) of the EUT shall not be less than the values specified in **Table 3**.

Conditions: The EUT was setup as described in Section I Subpart J of this EMITR. The EUT was examined for shielding effectiveness at discrete frequencies specified in **Table 3** Manual data collection techniques were used to insure accuracy. Only vertical antenna polarizations were tested. Test sample #1-3 were evaluated (see Section A of this test report).

Procedure:

Bore-sight "Direct" and "Indirect" SE testing:

DIRECT MEASUREMENTS

First, a "**Direct**" baseline measurement to normalize the antenna efficiencies, test equipment characteristics, and Chamber shielding effectiveness attenuation was performed by positioning a transmitting antenna 1.0 meter above the floor and axially separated ~2.0m (d_1) from the receive antenna- clear of any metallic objects (see **Figure 1** below). Multiple antenna sets were used to cover the frequency spectrum being investigated, if necessary. An RF Signal Generator outputted an un-modulated sinusoidal RF signal at discrete frequencies into power amplifier(s) used to overcome the dynamic range of the test equipment and test setup. Remotely, over fiber optic interface, an RF signal generator was incremented at discrete frequencies, identified in **Table 3**, with pre-determined amplitudes fed into RF amplification located inside the test chamber. At the end of each test frequency, the test engineer manually recorded the peak RMS value from the spectrum analyzer and documented this amplitude into tabular datasheet format.

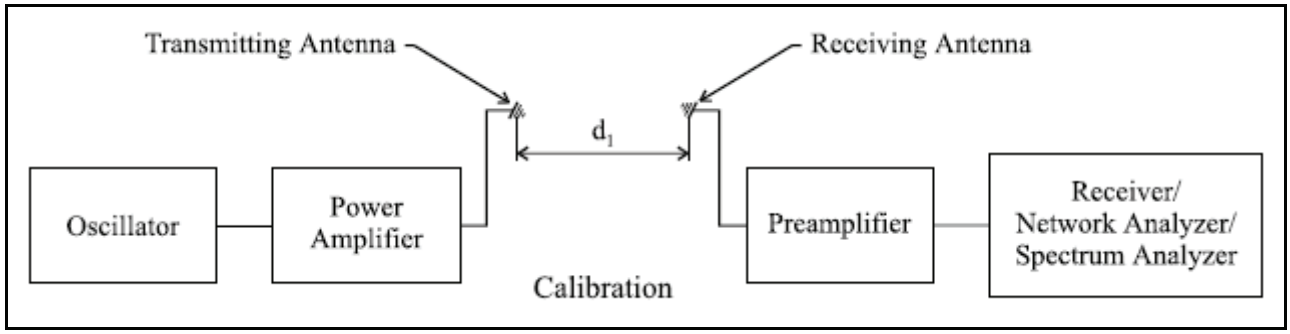


Figure 1. Test Setup for Test Chamber "Direct" baseline measurements

The purpose of the "**Direct**" measurements is to quantify the dynamic range of the test environment, namely the test chamber, and to verify that the test environment did not introduce any ambient noise into the actual SE measurements.

The "**Direct**" measurement was determined by establishing a reference RF Power level sufficient to drive through free-space attenuation between the test antennas. This "RF Reference power level" was obtained by aligning a pair of antennas in a vertical co-planar orientation with a separating distance of ~2.0m tip-to-tip. The transmitter and receiver test equipment was synchronously tuned to the discrete test frequencies by the test engineer. Care was observed not to over-drive or saturate the receive test measuring equipment (aka Spectrum Analyzer).

INDIRECT MEASUREMENTS

"**Indirect**" measurements were used to determine shielding effectiveness of the test chamber, and the shielding effectiveness of a particular test sample (EUT).

The **first phase** of "Indirect" measurement for shielding effectiveness of the test chamber was obtained by aligning a pair of antennas in a vertical co-planar orientation with the same separating test distance of ~2.0m (d_2 and d_3) tip-to-chamber bulkhead (see **Figure 2**). The "blank" test chamber bulkhead panel was installed into the bulkhead to pre-determined torque specifications. The recorded RF Signal Generator "RF Reference Power Level" setting from the "Direct" procedure was replayed. The transmitter and receiver test equipment was manually synchronously tuned to the discrete test frequencies by the test engineer. Because of the electromagnetic barrier of the test chamber, the measured amplitude of the discrete RF frequency points identified in **Table 3**, as expected, seriously attenuated.

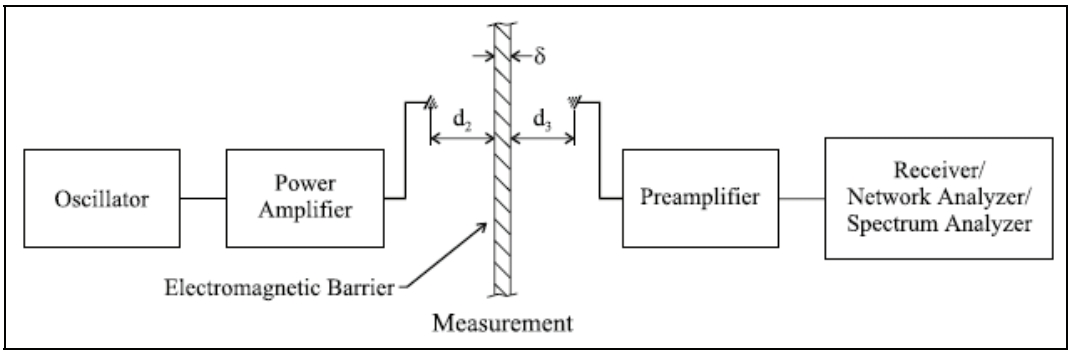


Figure 2. Test Setup for first phase of "Indirect" measurements

The **second phase** of the SE measurement procedure was to quantify an "Indirect" measurement where the test sample was installed into an electromagnetic barrier in between the transmitting and receive antenna as illustrated in **Figure 3** below. Similar "Indirect" first phase measurements procedures was performed; the only difference being that the test sample is installed in the bulkhead panel outer ring and intruded into the radiating electric field. The transmitter and receiver test equipment was manually synchronously tuned to the discrete test frequencies by the test engineer. Because of the dimensional constraints of the test sample, the measured amplitude of the discrete RF frequency points replayed will be of at least higher amplitude compared to the amplitude of the test chamber thereby producing less shielding effectiveness as compared to the SE of the test chamber.

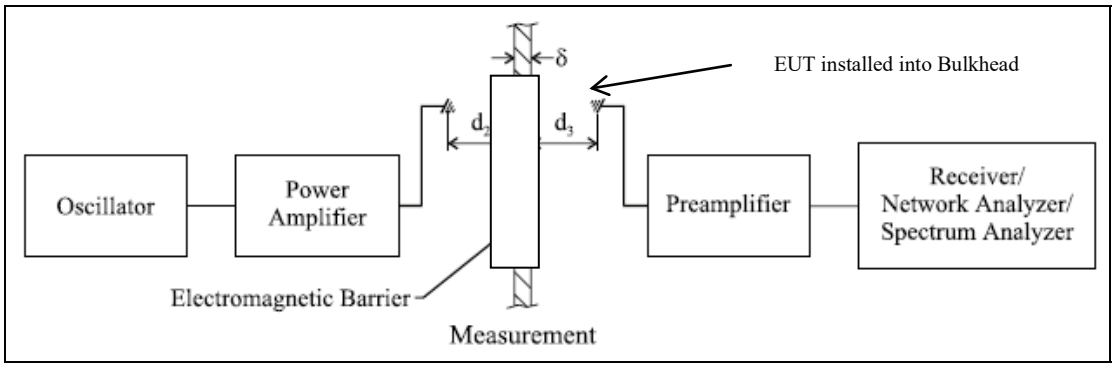


Figure 3. Test Setup for "Indirect" SE measurements of the test sample

Test Dates: November 29, 2017

Test Engineer: Long Ton

Test Results:

Data is presented in tabular and graphical format specifying the specific test sample(s) tested, calibrated baselines (Direct Measurement through an open test chamber bulkhead), measured SE of the test sample. All test equipment and calibration information is aforementioned.

Frequency (MHz)	Noise Floor Measurement (dBm)		Direct Measurement (dBm)		Dynamic Range (dB)		Steel Panel Isolation (dBm)		Shielding Effectiveness of Steel Panel (dB)	
	Co-Axial	Co-Planar	Co-Axial	Co-Planar	Co-Axial	Co-Planar	Co-Axial	Co-Planar	Co-Axial	Co-Planar
0.01	-118.69	-119.33	-42.01	-61.5	**76.68**	**57.83**	-96.62	-100.76	**54.61**	**39.26**
0.15	-123.28	-124.87	-43.36	-62.78	**79.92**	**62.09**	-114.1	-110.71	**70.74**	**47.93**
15.00	-127.67	-130.25	-40.93	-53.83	**86.74**	**76.42**	-136.92	-136.98	**95.99**	**83.15**

Table 4. Shielding Effectiveness, EMC Shielding Wallpaper, Isolation 1

Frequency (MHz)	Noise Floor Measurement (dBm)		Direct Measurement (dBm)		Dynamic Range (dB)		Steel Panel Isolation (dBm)		Shielding Effectiveness of Steel Panel (dB)	
	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
30.00	-124.76	-123.88	-26.08	-5.81	**98.68**	**118.07**	-126.2	-94.75	**100.12**	**88.94**
31.30	-125.43	-129.42	-23.99	-7.98	**101.44**	**121.44**	-127.83	-96.78	**103.84**	**88.8**
34.80	-127.97	-128.75	-16.73	-14.5	**111.24**	**114.25**	-122.89	-107.3	**106.16**	**92.8**
38.30	-127.88	-126.47	-8.07	-7.95	**119.81**	**118.52**	-118.26	-106.5	**110.19**	**98.55**
100.00	-124.56	-123.4	-2.62	0.59	**121.94**	**123.99**	-98.08	-92.12	**95.46**	**92.71**
400.00	-124.5	-123.68	3.65	2.49	**128.15**	**126.17**	-76.63	-96	**80.28**	**98.49**
800.00	-126.5	-123.87	-0.61	-1.19	**125.89**	**122.68**	-106.73	-112.03	**106.12**	**110.84**
1000.00	-123.8	-122.1	-7.38	-7.22	**116.42**	**114.88**	-105.17	-90.08	**97.79**	**82.86**
2000.00	-122.3	-121.52	-33.59	-30.23	**88.71**	**91.29**	-126.67	-127.14	**93.08**	**96.91**
4000.00	-119.2	-118.92	-20.39	-21.32	**98.81**	**97.6**	-125.61	-127.08	**105.22**	**105.76**
5000.00	-121.1	-120.7	-21.78	-21.67	**99.32**	**99.03**	-125.98	-126.59	**104.2**	**104.92**
10000.00	-120.8	-121.1	-29.35	-28.07	**91.45**	**93.03**	-125.17	-125.38	**95.82**	**97.31**
18000.00	-122.8	-121.4	-41.67	-40.21	**81.13**	**81.19**	-122.76	-121.76	**81.09**	**81.55**

Table 5. Shielding Effectiveness, EMC Shielding Wallpaper, Isolation 2

Frequency (MHz)	Foil Sheet Wallpaper Measurement (dBm)		Foil Sheet Wallpaper Shielding Effectiveness (dB)		Minimum SE (dB)
	Co-Axial	Co-Planer	Co-Axial	Co-Planer	
0.01	-58.89	-72.36	16.88	10.86	10.86
0.15	-135.68	-93.41	92.32	30.63	30.63
15.00	-125.3	-127.8	84.37	73.97	73.97

Table 6. Shielding Effectiveness, EMI Shielding Wallpaper, Test Results 1

Frequency (MHz)	Foil Sheet Wallpaper Measurement (dBm)		Foil Sheet Wallpaper Shielding Effectiveness (dB)		Minimum SE (dB)
	Horizontal	Vertical	Horizontal	Vertical	
30.00	-121.95	-126.66	95.87	120.85	95.87
31.30	-120.22	-133.72	96.23	125.74	96.23
34.80	-123.21	-106.2	106.48	91.7	91.7
38.30	-116.27	-103.2	108.2	95.25	95.25
100.00	-126.87	-134.14	124.25	134.73	124.25
400.00	-140.75	-130.22	144.4	132.71	132.71
800.00	-116	-115.61	115.39	114.42	114.42
1000.00	-123.2	-117.46	115.82	110.24	110.24
2000.00	-140.39	-140.44	106.8	110.21	106.8
4000.00	-143.61	-142.35	123.22	121.03	121.03
5000.00	-141.22	-141.88	119.44	120.21	119.44
10000.00	-139.55	-138.98	110.2	110.91	110.2
18000.00	-133.88	-136.45	92.21	96.24	92.21

Table 7. Shielding Effectiveness, EMI Shielding Wallpaper, Test Results 2

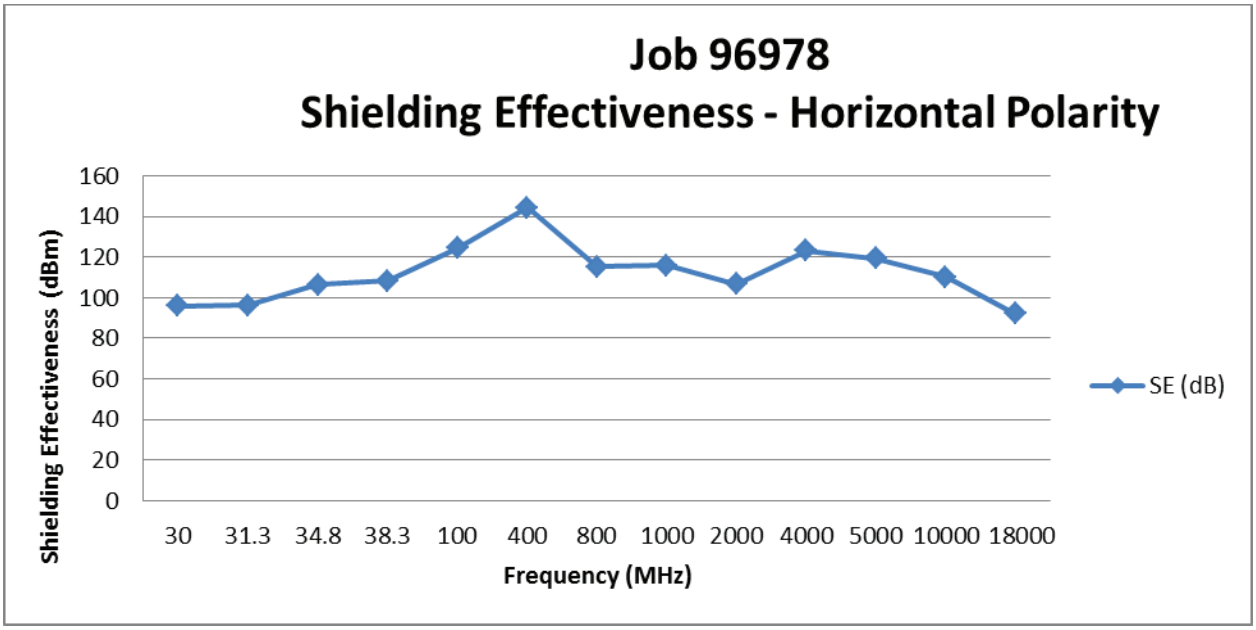


Chart 1. Shielding Effectiveness Summary, Horizontal Polarity Result

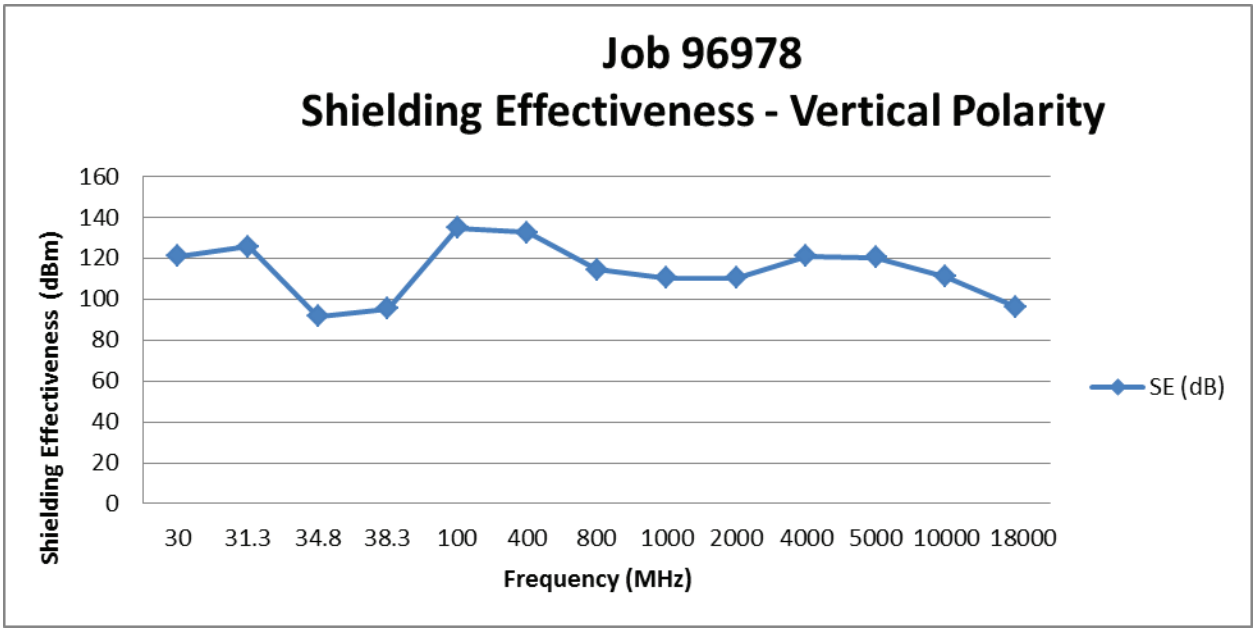


Chart 2. Shielding Effectiveness Summary, Vertical Polarity Result

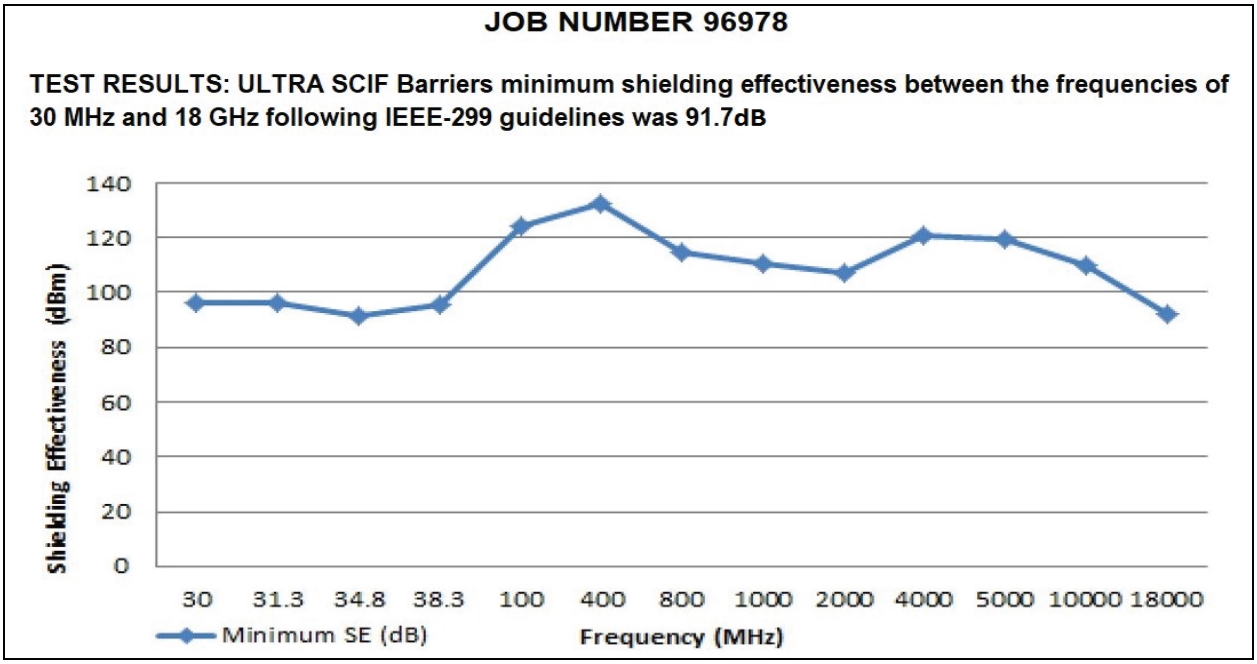
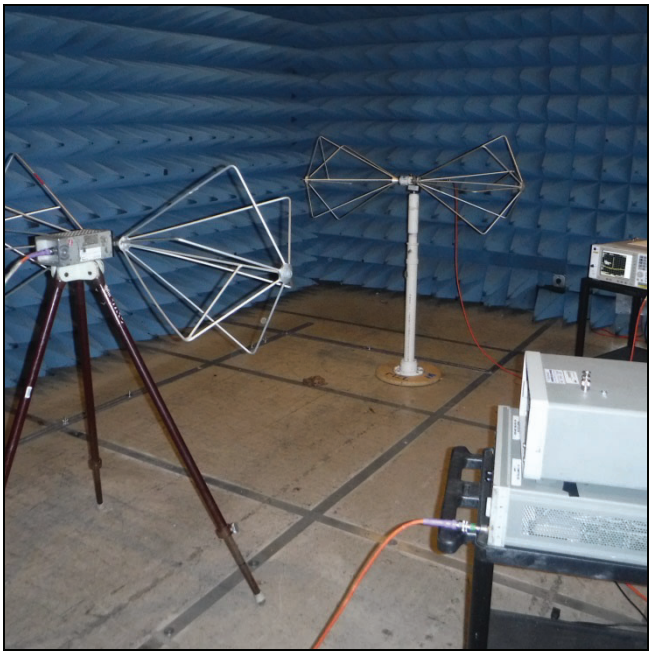
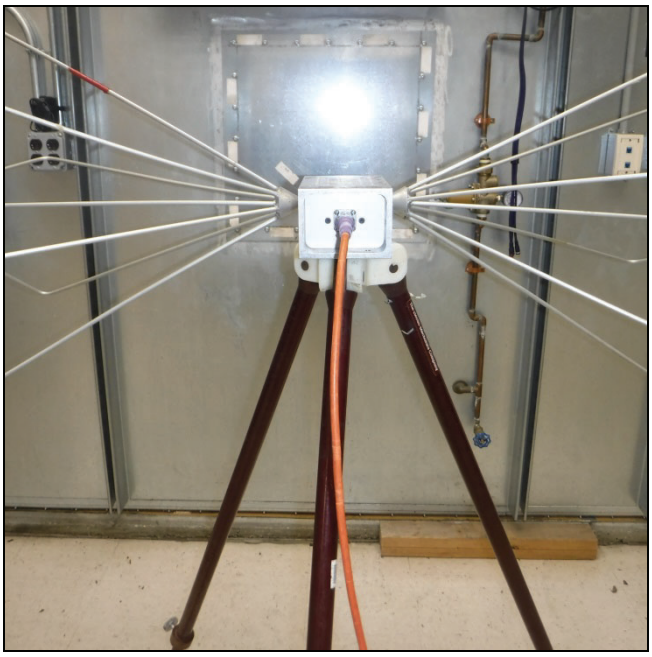


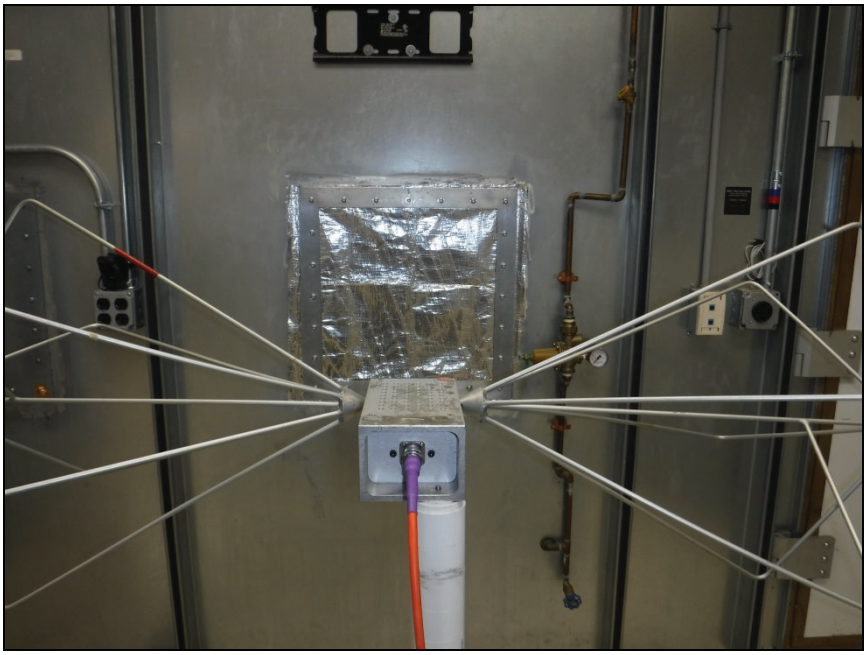
Chart 3. Shielding Effectiveness Summary, Minimum Result



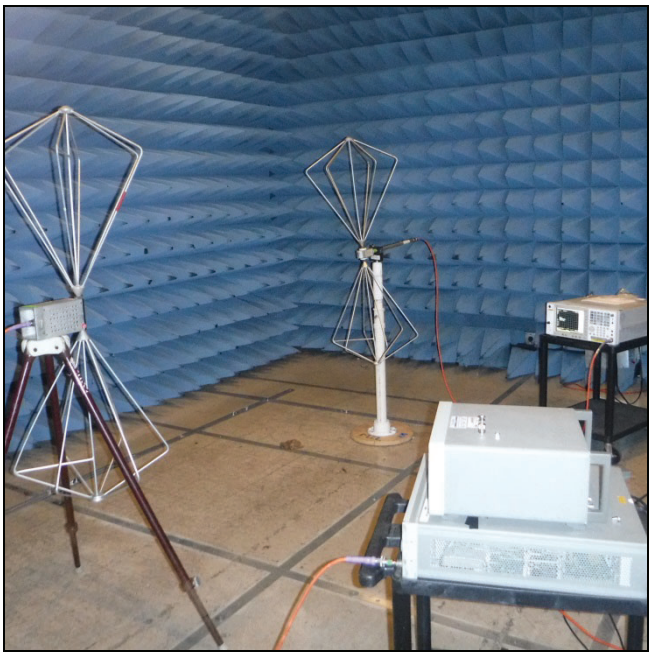
Photograph 1. Shielding Effectiveness, Bicon, Horizontal, Direct Measurement



Photograph 2. Shielding Effectiveness, Bicon, Horizontal, Isolation

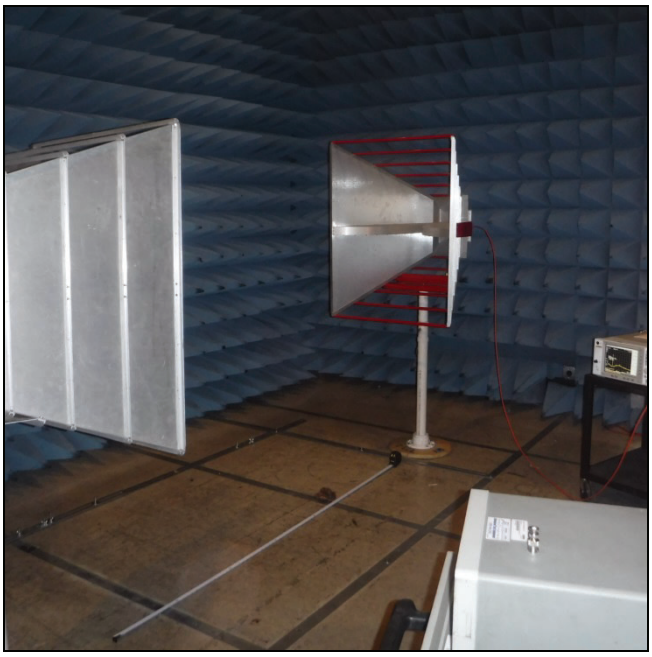


Photograph 3. Shielding Effectiveness, Bicon Test

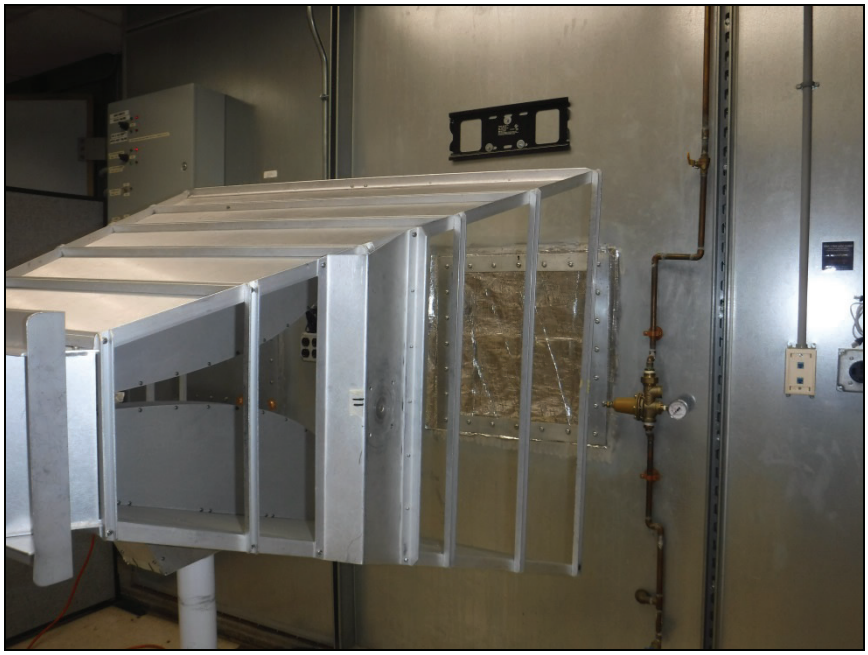


Photograph 4. Shielding Effectiveness, Bicon, Vertical Direct Measurement

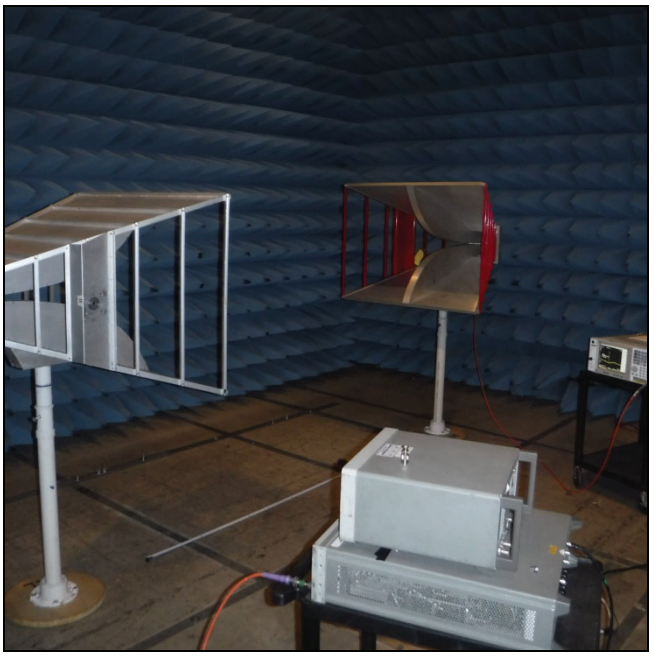
Photograph 5. Shielding Effectiveness, Bicon, Vertical, Isolation



Photograph 6. Shielding Effectiveness, BigHorn, Horizontal, Direct Measurement

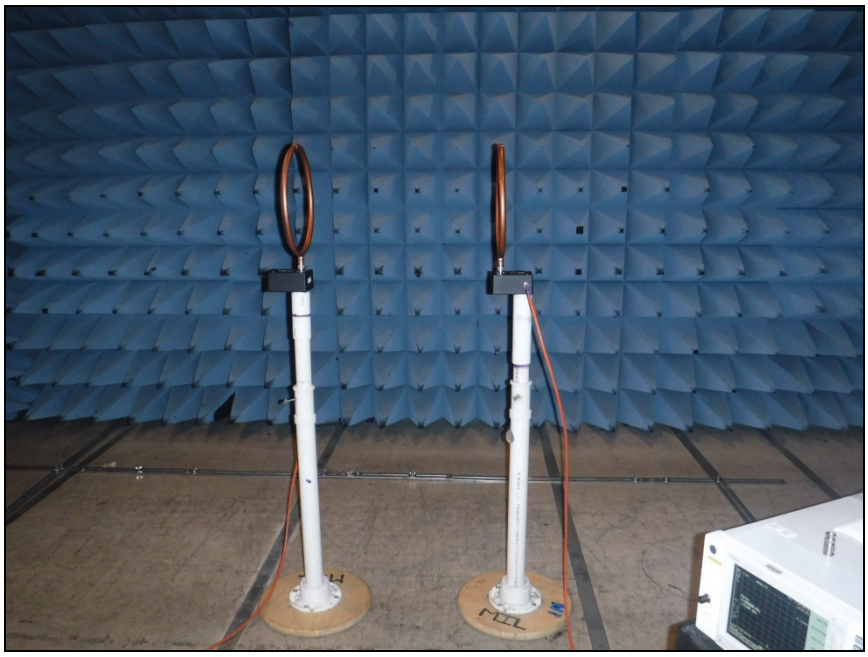


Photograph 7. Shielding Effectiveness, BigHorn, Test

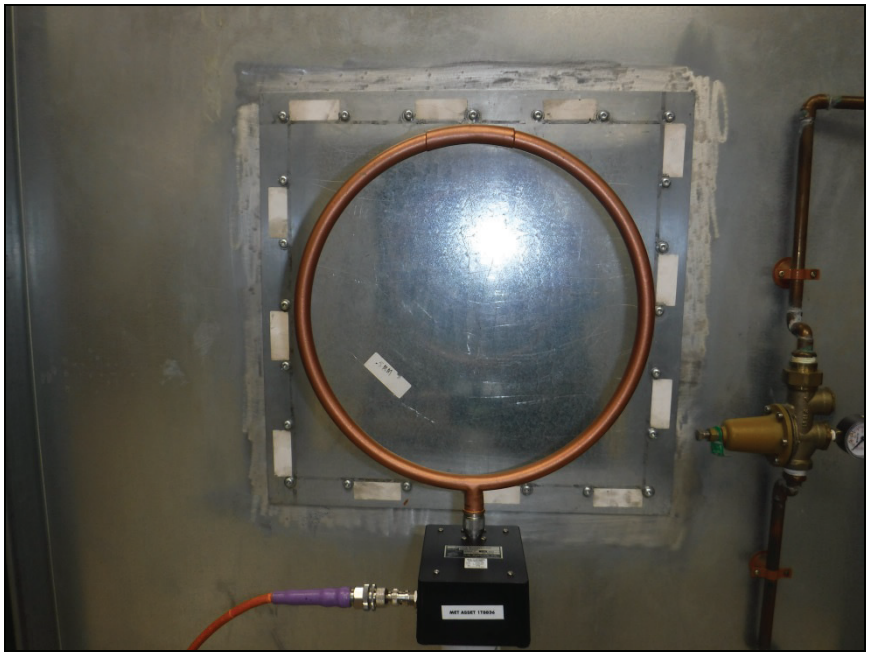


Photograph 8. Shielding Effectiveness, BigHorn, Vertical, Direct Measurement

Photograph 9. Shielding Effectiveness, BigHorn, Vertical, Isolation

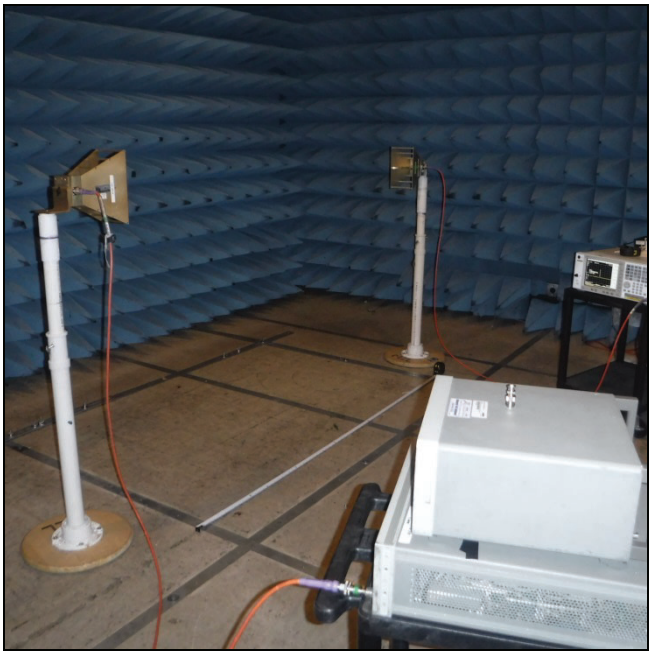


Photograph 10. Shielding Effectiveness, Loop, Direct Measurement



Photograph 11. Shielding Effectiveness, Loop, Isolation

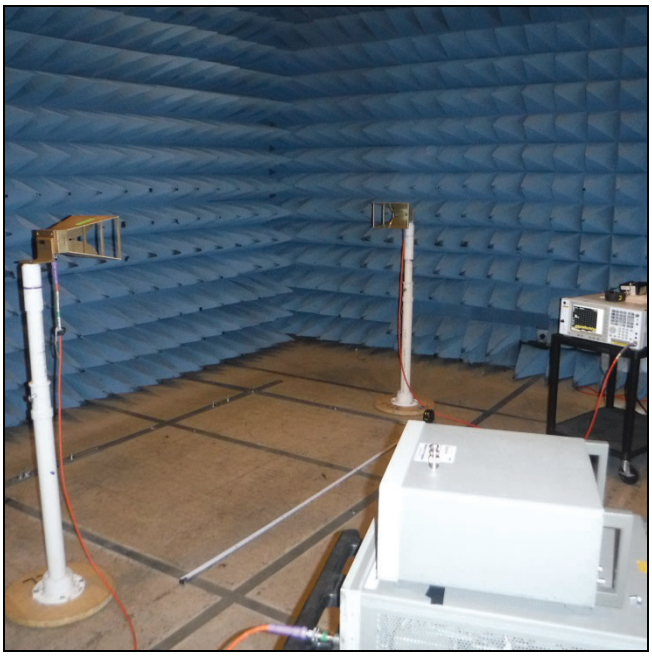
Photograph 12. Shielding Effectiveness, Loop Test



Photograph 13. Shielding Effectiveness, SmallHorn, Horizontal, Direct Measurement

Photograph 14. Shielding Effectiveness, SmallHorn, Horizontal, Isolation

Photograph 15. Shielding Effectiveness, SmallHorn, Test



Photograph 16. Shielding Effectiveness, SmallHorn, Vertical, Direct Measurement

Photograph 17. Shielding Effectiveness, SmallHorn, Vertical, Isolation

MET #	Equipment	Manufacturer	Model#	Cal Date	Cal Due
1T4271	SIGNAL GENERATOR	HP	8648C	04/06/17	10/06/18
1T8744	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4440A	05/19/17	05/19/18
1T4354	SIGNAL GENERATOR	HEWLETT PACKARD	83752A	06/21/17	12/21/18
1T4331	AMPLIFIER WIDEBAND RF	IFI	SMX100	SEE NOTE	
1T4635	ANTENNA - BICONICAL	EMCO	3110	08/10/17	02/10/19
1T2658	ANTENNA; BICON	EMCO	3109	08/15/16	02/15/18
1T8371	DOUBLE RIDGE GUIDE HORN ANTENNA	A.H. SYSTEMS, INC.	SAS-571	02/14/17	02/14/18
1T4905	HORN ANTENNA	COM-POWER	AH-118	09/25/17	03/25/19
1T 8836	ANTENNA (ACTIVE 12" LOOP)	A.H. SYSTEMS	SAS-563P	SEE NOTE	
1T 8837	ANTENNA (ACTIVE 12" LOOP)	A.H. SYSTEMS	SAS-563B	SEE NOTE	
1T4765	ANTENNA; DRG HORN	ETS-LINDGREN	3106B	01/17/17	07/17/18
1T4375	DOUBLE RIDGED WAVEGUIDE HORN	ETS-LINDGREN	3106	10/24/17	04/24/19
1T4767	CHAMBER 8	ETS-LINDGREN	S 201-8X8-LH	SEE NOTE	

Table 8. Shielding Effectiveness, Test Equipment

End of Test Report