SRG

Shielding Resources Group, Inc.

RADIO FREQUENCY SHIELDING EFFECTIVENESS TEST REPORT

TEST REPORT NUMBER TR-TRU-PROTECT-M

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1.0 INTRODUCTION

This document is a report of attenuation/shielding effectiveness testing conducted on a RF shielded enclosure located at Shielding Resources Group, Inc. (SRG). The primary purpose of this test was to determine the levels of shielding effectiveness that the enclosure afforded with the introduction of RF shielded components manufactured by Shielding Resources Group, Inc. (SRG), The enclosure is located at the office/manufacturing facility of SRG, 9512 E. 55th Street, Tulsa, Oklahoma 74145. The intended use or purpose of this enclosure is to determine what levels of RF shielding effectiveness are attained with 3 layer Tru-Protect" panels and SRG components..

Testing was performed by Shielding Resources Group, Inc. in accordance with MIL-STD-285 (frequency modified), for the purpose of shielding effectiveness performance verification. Testing consisted of measurements of the enclosures shielding effectiveness characteristics following the procedures of MIL-STD-285, IEEE 299, modified and NSA 73-2A.

2.0 DESCRIPTION OF THE TEST ARTICLE

The article under test was a fixed site RF shielded enclosure which was designed to be an externally supported, (RF Shielding media attached to a host substrate). The RF panels were supplied by Tru-Protect and the door, electrical filter(s), honeycomb waveguides and floor were supplied by SRG.

The host structure was fabricated with conventional 2 X 4 steel studs and 2 X 4 steel stud tracks. The stud tracks were mechanically attached to SRG's modular floor panels. Once the stud tracks were secured, the studs and ceiling joists were installed. A layer of ½" OSB was attached to the interior stud walls and ceiling of the enclosure. This ½" layer of OSD was the mounting surface for the Tru-Protect panels.

The shielding media utilized for the walls and ceiling consisted of 3 layers 5 mil aluminum, designated as Tru-Protect product description "1/2" 3 Layers Alum 2 Board". To attain RF shielding effectiveness, the internal joints or seams of the 3 layer aluminum panels were "butted" together. Each "joint" was than sealed with a conductive 5mil aluminum tape.

The floor consisted of SRG's modular galvanized panels which were jointed along the edges with a counter sunk "hat & flat" assembly. A interface member was installed between the floor panel face and the wall panel face.

For the introduction of electrical power to the enclosure, attenuative power filters were used. The power filters were designed to comply with the requirements of MIL-STD-220A. Heating, air conditioning was introduced through the use of SRG's 3/16" X 1" steel honeycomb waveguide (which was installed in a "L" angle frame. The RF shielded door was a 3'-0" X 7'-0" SRG "ULTRA-COVERT" series door.

3.0 SHIELD PERFORMANCE CRITERIA

The performance criteria of the RF shield enclosure is to provide an interference free environment and eliminate RFI signals within the shielded environment when tested in accordance with MIL-STD-285 and IEEE 299. It is noted, that due to the design characteristics of the shielding media, a single point ground was not attained or attempted.

Shielding effectiveness (or attenuation) is defined as the level of electromagnetic reduction provided by a shield. For this purpose, the shielded environment was tested to determine what levels of shielding effectiveness (or attenuation) are attainable with the Tru-Protect panels and the SRG components. The goal shielding effectiveness is as shown in paragraph 3.1 which is based on NSA 73-2A. Since this was a determination of shielding effectiveness, no required vale of S/E is given.

3.1 RF SHIELDING

FREQUENCY	*FIELD*	*SHIELDING EFFECTIVENESS*
10 MHz	*Electric Field*	*TBD*
50 MHz	*Electric Field*	*TBD*
100 MHz	*Electric Field/Plane Wave*	*TBD*
400 MHz	*Plane Wave*	*TBD*
1 GHz	*Plane Wave/Micro Wave*	*TBD*
2 GHz	*Micro Wave*	*TBD*
3 GHz	*Micro Wave*	*TBD*
4 GHz	*Micro Wave*	*TBD*
5 GHz	*Micro Wave*	*TBD*
6 GHz	*Micro Wave*	*TBD*
7 GHz	*Micro Wave*	*TBD*
8 GHz	*Micro Wave*	*TBD*
9 GHz	*Micro Wave*	*TBD*
10 GHz	*Micro Wave*	*TBD*

4.0 SHIELDING EFFECTIVENESS REFERENCE AND MEASUREMENT PROCEDURE

The following procedures describe the method of test which was used to determine the levels of attenuation (shielding effectiveness) of the RF enclosure. During the test process, the transmit and receive antennas were co-polarized.

During electric field and plane wave attenuation measurements, the transmit antenna was located in a fixed position at each test point location. The receive antenna was scanned over a five (5) foot distance (where practical) from the test point location, where possible and at a fixed distance from the shield surface. When testing HVAC openings, electrical filters and penetrations, full scans were made over the entire area.

Figures 1 through 4 depict test equipment arrangements of test equipment for plane wave levels and shielding effectiveness (attenuation) measurements.

4.1 ELECTRIC FIELDS (HIGH IMPEDANCE)

Prior to performing the shielding effectiveness measurements, a reference level and dynamic range was established. To establish the reference level and dynamic range, the transmit (tunable rod/monopole) antenna and the receive (tunable rod/monopole) antenna were placed outside of the enclosure to ensure there was no case leakage of the receiver or spectrum analyzer. The antennas were placed twenty-four inches (24") apart plus the thickness of the shielding media which is approximately one inch (1") thick, for a total separation of twenty-five inches (25") as depicted in Figure 1. The antennas were oriented in a vertical polarization during the reference level and dynamic range establishment procedure.

FIGURE 1

The received signal level value was recorded in the "Reference Level" (REF LEVEL, dBm) column of the "Shielding Effectiveness Test Results" form. The reference level value was determined by combining the value of any external attenuation and the received signal level which was displayed on the spectrum analyzer (or receiver).

With the reference level established and recorded, the receiver sensitivity (or noise floor) was determined. This was accomplished by placing the receive antenna inside of the enclosure and removing any fixed attenuation and or any spectrum analyzer/receiver internal attenuation. If pre amplification of the received signal was required, the pre amplifier remained on during this measurement. The receiver sensitivity level, which is in dBm, was recorded in the "Receiver Sensitivity" (RCV SEN, dBm) column of the "Shielding Effectiveness Test Results" form. During this measurement, there was no power amplifier connected to the output of the transmitter or source.

The system or measurement dynamic range was now be established. The dynamic range, which is recorded in the "DYNAMIC RANGE" column of the "Shielding Effectiveness Test results" form is the numerical difference between the reference level value and the receiver sensitivity value.

With the reference level, receiver sensitivity and dynamic range established and recorded, the receive antenna was placed at a predetermined test point location within the enclosure. The distance of the antenna to the shield surface (panel) was twelve inches (12") and in the same orientation as was used during the reference establishment. The source antenna was placed at the same test point but on the outside of the enclosure. The antenna was placed twelve inches (12") from the shield surface (panel) and in the same orientation as the receive antenna (Figure 2). Any fixed attenuators that were used during the reference establishment were removed from the receive or transmit lines and the enclosure door(s) was closed.

FIGURE 2

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The received signal level at this point was recorded in the "Receiver Level" (RCV LEVEL, dBm) column of the "Shielding Effectiveness Test Results" form. The numeric difference between the "Reference Level" and the "Receiver Level" is the attenuation or shielding effectiveness of this test point. This value was recorded in the "Attenuation (S/E), dB column of the "Shielding Effectiveness Test Results" form. The transmit and receive antennas were placed at the remaining test point locations and the received signal levels were recorded. Upon *completion of all test points, a second reference level was taken to ensure that the source gain or receiver sensitivity did not change. The lowest recorded value is the attenuation or shielding effectiveness at this frequency.*

4.2 <u>PLANE WAVE</u>

Frequencies of test for plane wave measurements were as listed in Table Section 3.1.

Prior to performing the shielding effectiveness measurements, a reference level and dynamic range was established. To establish the reference level and dynamic range, the transmit (dipole or log periodic) antenna and the receive (dipole or log periodic) antenna were placed outside of the enclosure to ensure there was no case leakage of the receiver or spectrum analyzer. The antennas were placed seventy-four inches (74") apart plus the thickness of the shielding media which is approximately one inch (1") thick, for a total separation of seventy-five inches (75") as depicted in Figure 3. The antennas were co-polarized (either horizontally or vertically) during the reference level and dynamic range establishment procedure.

<u>FIGURE 3</u>

The received signal level value was recorded in the "Reference Level" (REF LEVEL, dBm) column of the "Shielding Effectiveness Test Results" form. The reference level value was determined by combining the value of any external attenuation and the received signal level which was displayed on the spectrum analyzer (or receiver).

With the reference level established and recorded, the receiver sensitivity (or noise floor) was determined. This was accomplished by placing the receive antenna inside of the enclosure and removing any fixed attenuation and or any spectrum analyzer/receiver internal attenuation. If pre amplification of the received signal was required, the pre amplifier remained on during this measurement. The receiver sensitivity level, which is in dBm, was recorded in the "Receiver Sensitivity" (RCV SEN, dBm) column of the "Shielding Effectiveness Test Results" form. During this measurement, there was no power amplifier connected to the output of the transmitter or source.

The system or measurement dynamic range was now established. The dynamic range, which is recorded in the "DYNAMIC RANGE" column of the "Shielding Effectiveness Test results" form is the numerical difference between the reference level value and the receiver sensitivity value.

With the reference level, receiver sensitivity and dynamic range established and recorded, the receive antenna was placed at a predetermined test point location within the enclosure. The distance of the antenna to the shield surface (panel) was less than two inches (2") and in the same orientation as was used during the reference establishment. The source antenna was placed at the same test point but on the outside of the enclosure. The antenna was placed seventy-two inches (72") from the shield surface (panel) and in the same orientation as the receive antenna (Figure 4). Any fixed attenuators that were used during the reference establishment were removed from the receive or transmit lines and the enclosure door(s) was closed.

FIGURE 4

The received signal level at this point was recorded in the "Receiver Level" (RCV LEVEL, dBm) column of the "Shielding Effectiveness Test Results" form. The numeric difference between the "Reference Level" and the "Receiver Level" is the attenuation or shielding effectiveness of this test point. This value was recorded in the "Attenuation (S/E), dB column of the "Shielding Effectiveness Test Results" form. The transmit and receive antennas were then placed at the remaining test point locations and the received signal levels were recorded. Upon completion of all test points, a second reference level was taken to ensure that the source gain or receiver sensitivity did not change.

The lowest recorded value is the attenuation or shielding effectiveness at this frequency.

5.0 TEST RESULTS

This section contains tabulated data (lowest & highest reading) resulting from the RF radiated shielding effectiveness tests. Copies of the actual test data and test point locations can be found in Appendix A and Appendix B.

5.1 RADIATED RF TEST DATA, PRE-SCAN

FREQUENCY	FIELD	REQUIRED ATTENUATION	ACTUAL ATTENUATION
10 MHz	Electric	N/A dB	>/= 72 dB
50 MHz	Electric	N/A dB	>/= 64 dB
100 MHz	Plane Wave	N/A dB	>/= 72 dB
400 MHz	Plane Wave	N/A dB	>/= 70 dB
1 GHz	Plane Wave	N/A dB	>/= 64 dB
2 GHz	Microwave	N/A dB	>/= 62 dB
3 GHz	Microwave	N/A dB	>/= 64 dB
4 GHz	Microwave	N/A dB	>/= 66 dB
5 GHz	Microwave	N/A dB	>/= 70 dB
6 GHz	Microwave	N/A dB	>/= 68 dB
7 GHz	Microwave	N/A dB	>/= 62 dB
8 GHz	Microwave	N/A dB	>/= 66 dB
9 GHz	Microwave	N/A dB	>/= 72 dB
10 GHz	Microwave	N/A dB	>/= 68 dB

6.0 <u>CONCLUSIONS & RECOMMENDATIONS</u>

The intent of this test was to determine the level of shielding effectiveness the enclosure would provide over the frequency range of 10 MHz to 10 GHz. It was found, based upon recorded data, that the enclosure with the Tru-Protect panels (and various components), meets and exceeds the requirements of NSA 73-2A and NACSEM 5204, where applicable.

It is felt that this type of construction (panels) can attain higher levels of S/E, but for this evaluation, components that meet and exceed the “40 to 60 dB spec” commonly specified by certain agencies were utilized.

APPENDIX A
TEST POINT LOCATIONS
(NOT TO SCALE)

APPENDIX B
TEST DATA SHEET

APPENDIX B
TEST DATA SHEET

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