



Advanced Programs, Inc.
Cyber Assurance Services
7090 Columbia Gateway Drive, Suite 150
Columbia, MD 21046

IEEE-299/ASTM F3057-16 Shielding Effectiveness Test Report
for the
Fi-FOIL RF Shield Foil Perforated
Fi-FOIL RF Shield Foil Non-Perforated

October 2018

Prepared for:
Fi-FOIL Company
612 Bridgers Ave. West
Auburndale, FL 33823

Prepared by:
Advanced Programs, Inc.
Cyber Assurance Services
7090 Columbia Gateway Drive, Suite 150
Columbia, MD 21046
(410) 312-5800

Fi-FOIL Purchase Order Number: 103705
API Job Number: TS18-1064

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PREPARED BY:

A handwritten signature in dark ink, appearing to read "R. Todd Humphreys". The signature is fluid and cursive, with the first name "R." and last name "Humphreys" clearly distinguishable.

R. Todd Humphreys
Director, Cyber Assurance Services
EMI/TEMPEST/Shielding Effectiveness Test Lab

FORWARD

The shielding effectiveness evaluation was performed on two Fi-FOIL foil samples as specified herein, which were tested in accordance with IEEE-299, "IEEE Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures" using the test fixture as called out in ASTM F3057-16, "Standard Test Method for Electromagnetic Shielding Effectiveness". The Fi-FOIL foil test samples measured 36 inches wide by 36 inches tall in accordance with ASTM F3057-16 sample size requirements. The two test samples were identified as Fi-FOIL RF Shield Foil Perforated and Fi-FOIL RF Shield Foil Non-Perforated.

The samples were evaluated in the Electric and Plane Wave fields from 100 MHz to 18 GHz. Antenna measurements were performed polarized in the Horizontal orthogonal plane only as requested by the customer. This evaluation was performed under Fi-FOIL purchase order number 103705.

The test samples shielding effectiveness was measured by comparing the level of a signal propagating through the 34 inch by 34 inch open hole in the test fixture with no sample (Open Hole reference run measurement per 13.1.3 in ASTM F3057-16) with the RF signal propagating through the hole with the test sample installed in the test fixture. The difference in measurements is the shielding effectiveness for that sample.

The Fi-FOIL foil samples test results are presented in Appendix A of this report.

HISTORY OF REVISIONS

Page Number	Revision	Date	Description of Change
	-	10.2018	Initial Release

TABLE OF CONTENTS

REPORT COVER PAGE	1
SIGNATURE PAGE	2
FORWARD	3
HISTORY OF REVISIONS	4
TABLE OF CONTENTS	5
TABLES AND FIGURES	6
1.0 ADMINISTRATIVE DATA	7
1.1 SCOPE/PURPOSE OF EVALUATION	7
1.2 TEST LABORATORY ACCREDITATION	7
1.3 CONTRACT INFORMATION	7
1.4 TEST SAMPLE CLASSIFICATION	7
1.5 TEST LOCATION	7
1.6 DATES OF TESTS	7
1.7 TEST INSTRUMENTATION AND CALIBRATION	7
1.8 SUPPORT REQUIREMENTS	8
1.9 APPLICABLE DOCUMENTS	8
1.10 TEST PERSONNEL	8
1.11 CUSTOMER REPRESENTATIVE	8
1.12 LIST OF ABBREVIATIONS	8
1.13 TEST SAMPLES UNDER TEST DISPOSITION	9
2.0 MATERIAL UNDER TEST (MUT)	10
2.1 DESCRIPTION OF TEST SAMPLES	10
2.2 MODIFICATIONS INCORPORATED IN MUT	10
2.3 ADDITIONAL INFORMATION RELATED TO TESTING	10
2.4 CONDITION OF THE TEST SAMPLE	10
3.0 TEST RANGES	11
4.0 TEST CONDITIONS	12
4.1 GENERAL	12
4.2 TEST INSTRUMENTATION	12
4.3 MEASUREMENT TOLERANCES	12
4.4 SHIELDED ENCLOSURES	12
4.5 INSTALLATION OF MATERIAL UNDER TEST	12
4.6 BANDWIDTH AND MEASUREMENT	12
4.7 MEASUREMENT POINTS	13
4.8 TEST PROCEDURE	13
5.0 SHIELDING EFFECTIVENESS TEST RESULTS	20
5.1 DOCUMENTATION AND PRESENTATION OF THE TEST RESULTS	20
5.2 TEST DEVIATIONS	20
5.3 ENGINEERING STATEMENT	20
5.4 SUMMARY OF RESULTS	20
APPENDIX A TEST EQUIPMENT LIST AND ATTENUATION TEST RESULTS	21

TABLES AND FIGURES

HISTORY OF REVISIONS	4
Table 3-1. Test Frequency Range / Detection System / Measurement Points	11
Table 4-1 Test Ranges and Bandwidths Utilized to Perform Evaluation	13
Figure 4-1. Test Setup Photograph Example Transmit Antenna Side (100 MHz – 1 GHz)	14
Figure 4-2. Test Setup Photograph Example Receive Antenna Side (100 MHz – 1 GHz).....	15
Figure 4-3. Test Setup Photograph Example Transmit Antenna Side (1 GHz – 18 GHz).....	16
Figure 4-4. Test Setup Photograph Example Receive Antenna Side (1 GHz – 18 GHz).....	17
Figure 4-5. Test Setup Photograph of Outside the RF Shielded Test Enclosure (Receive Side)	18
Figure 4-6. Test Setup Photograph of Outside the RF Shielded Test Enclosure (Transmit Side)	19
Table A-1 Test Equipment List	22
Figure A-1 Fi-FOIL RF Shield (Non-Perforated), 100 MHz to 1 GHz, Antenna Horizontal Test Results.	23
Figure A-2 Fi-FOIL RF Shield (Non-Perforated), 1 GHz to 18 GHz, Antenna Horizontal Test Results.....	24
Figure A-3 Fi-FOIL RF Shield (Perforated), 100 MHz to 1 GHz, Antenna Horizontal Test Results.	25
Figure A-4 Fi-FOIL RF Shield (Perforated), 1 GHz to 18 GHz, Antenna Horizontal Test Results.	26

1.0 ADMINISTRATIVE DATA

1.1 Scope/Purpose of Evaluation

The IEEE-299/ASTM 3057-16 shielding effectiveness evaluation was performed on two Fi-FOIL foil test samples that were identified as Fi-FOIL RF Shield Foil Perforated and Fi-FOIL RF Shield Foil Non-Perforated, all measuring 36 inch high x 36 inch wide. The test samples were evaluated in the ASTM RF shielded test enclosure with the dimensions of 10 feet tall by 16 feet wide by 24 feet long. This evaluation was performed under Fi-FOIL purchase order number 103705.

1.2 Test Laboratory Accreditation

Advanced Programs Incorporated (API), Cyber Assurance Services has been accredited / approved by:

NSA : Endorsed TEMPEST test services facility
Intertek: ISO-9001:2015 Registered and Certification

1.3 Contract Information

Prime Contractor:
Fi-FOIL Company
612 Bridgers Ave. West
Auburndale, FL 33823

Subcontractor:
Advanced Programs Incorporated
Cyber Assurance Services
7090 Columbia Gateway Drive, Suite 150
Columbia, MD 21046

1.4 Test Sample Classification

The Fi-FOIL foil samples tested were unclassified.

1.5 Test Location

The IEEE-299/ASTM F3057-16 evaluation was performed in Laboratory 4/5 at:
Advanced Programs, Inc.
Cyber Assurance Services
7090 Columbia Gateway Drive, Suite 150
Columbia, MD 21046

1.6 Dates of Tests

The shielding effectiveness evaluation was performed from 2 February through 5 February 2018.

1.7 Test Instrumentation and Calibration

The test instrumentation required for the tests specified herein was furnished by the test laboratory, Advanced Programs Incorporated (API), Cyber Assurance Services and met the requirements of IEEE-299 and ASTM F3057-16. The calibration records of the standards and test instruments are on file at Advanced Programs Incorporated (API), Cyber Assurance Services, Columbia, Maryland, and are available for inspection. The test instrumentation nomenclature, property numbers and calibration due dates, where applicable, are included in this test report for all equipment utilized during the evaluation.

1.8 Support Requirements

Advanced Programs Incorporated (API), Cyber Assurance Services test laboratory personnel set up and operated the test equipment, entered all required data on data sheets, and performed computations necessary to obtain the corrected attenuation levels.

1.9 Applicable Documents

The following documents form a part of this test report to the extent specified:

- 1) IEEE Standard 299-1997, "IEEE Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures"
- 2) ASTM F3057-16 (2016), "Standard Test Method for Electromagnetic Shielding Effectiveness of Glazings"

1.10 Test Personnel

The following personnel were involved with the Attenuation evaluation and/or preparation of the test report:

R. Todd Humphreys, Director, Cyber Assurance Services
Tom Cahall., TEMPEST/EMI Engineer, CTP-I

1.11 Customer Representative

Bill Lippy, Fi-FOIL

1.12 List of Abbreviations

The following abbreviations may appear in this report.

BW	Bandwidth
cm	Centimeter
CW	Continuous Wave
dB	Decibel
EMI	Electromagnetic Interference
ER	Electric Field
EUT	Equipment Under Test
G	Giga – prefix for 10 to the 9 multiplier
Hz	Hertz
IR	Infrared
k	Kilo – prefix for 10 to the 3 multiplier
KVM	Keyboard/Video/Mouse Switch
M	Mega – prefix for 10 to the 6 multiplier
MR	Magnetic Field
MUT	Material Under Test
m	Meter
mm	Millimeter
NIST	National Institute of Standards and Technology
PW	Plane Wave
RF	Radio Frequency
rms	Root-Mean-Square
RX	Receive
SE	Shielding Effectiveness
TX	Transmit

u	Micro – prefix for 10 to the -6 multiplier
V	Volt
VBU	Verify Before Use

1.13 Test Samples Under Test Disposition

The test samples will be returned to Fi-FOIL after test completion or destroyed after 90 days if not requested by the customer.

2.0 MATERIAL UNDER TEST (MUT)

2.1 Description of Test Samples

The IEEE-299/F3057-16 shielding effectiveness evaluation was performed on two Fi-FOIL foil test samples that were identified as Fi-FOIL RF Shield Perforated and Fi-FOIL RF Shield Non-Perforated, measuring 36 inch high x 36 inch wide.

2.2 Modifications Incorporated In MUT

No modifications were done to the MUT during the shielding effectiveness evaluation.

2.3 Additional Information Related To Testing

The attenuation evaluation was performed utilizing unmodulated CW Transmit signals.

2.4 Condition of the test sample

The test samples were evaluated in a normal laboratory shielded enclosure "RF quiet" environment.

3.0 TEST RANGES

Table 3-1 lists the test specification and Test Frequency Range / Radiated Field / Measurement Points for each test method evaluated:

Table 3-1. Test Frequency Range / Detection System / Measurement Points

Test Specification	Test Frequency Range / Radiated Field / Measurement Points
ASTM F3057-16 / IEEE Standard 299-1997	100 MHz to 1 GHz / Electric/PW Field / 25 MHz Steps/Measurements
	1 GHz to 18 GHz / PW Field / 50 MHz Steps/Measurements

4.0 TEST CONDITIONS

4.1 General

The evaluation was performed following the test procedures stated in this report and applicable standards.

4.2 Test Instrumentation

All Advanced Programs Incorporated (API), Cyber Assurance Services supplied test equipment is calibrated using standards directly traceable to the National Institute of Standards and Technology (NIST), natural physical constants, consensus standards, or by ratio type measurements using self-calibrating techniques. Calibration of all test equipment is in accordance with MIL-STD-45662A, with calibration records on file at Advanced Programs Incorporated (API), Cyber Assurance Services, Columbia, Maryland 21046 and is available for inspection by cognizant government and industrial personnel.

The test equipment utilized for the shielding effectiveness evaluation is recorded in Appendix A. The equipment list identifies each piece of equipment by manufacturer, model number and property number.

4.3 Measurement Tolerances

Unless otherwise stated for a particular measurement, the tolerance shall be as follows:

- A) Distance: $\pm 5\%$
- B) Frequency: $\pm 2\%$
- C) Amplitude, measurement receiver: $\pm 2\text{ dB}$
- D) Amplitude, measurement system (includes measurement receivers, cables, and so forth): $\pm 3\text{ dB}$
- E) Time (waveforms): $\pm 5\%$
- F) Resistors: $\pm 5\%$
- G) Capacitors: $\pm 20\%$

4.4 Shielded Enclosures

To help minimize environmental ambient or interference from the outside environment and test equipment, RF shielded enclosures are required for testing. These enclosures prevent external environmental and test equipment signals from contaminating emission measurements and transmitted test signals from interfering with electrical and electronic items in the vicinity of the test facility (FCC requirement). These RF shielded enclosures provide 100 dB average attenuation of environmental ambient to satisfy the shielding effectiveness test requirements.

This evaluation was performed in an RF shielded test enclosures identified as lab numbers four and five. The test sample was placed in the test fixture. The test controller/computer was located outside of the RF shielded test enclosure. Through-wall connectors (BNC, Type N and SMA) provided the signal path from the transmit and receive antennas to the test generators, amplifiers and receiver located outside of the RF shielded test enclosure. Dimensions of the RF shielded test enclosure are approximately 16 ft. x 24 ft. x 10 ft. high.

4.5 Installation of Material Under Test

The samples of the Fi-FOIL RF Shield foil test samples were installed in the test fixture inside of RF shielded test enclosure numbers four and five with separating center wall test fixture. All items not needed for the evaluation were removed from inside lab numbers four and five. Figures 4-1 through 4-6 are photographs of the test setup and test equipment utilized to perform the evaluation.

4.6 Bandwidth and Measurement

The detection system bandwidths utilized to perform the attenuation evaluation are listed in Table 4-1.

Table 4-1 Test Ranges and Bandwidths Utilized to Perform Evaluation

Test frequency Range / Test	Bandwidth
100 MHz to 18 GHz / Electric Field and Plane Wave	1 kHz

4.7 Measurement Points

All measurements were made utilizing a two antenna (Transmit and Receive) method. Per the standard, 461 data points or more must be measured for each field.

4.8 Test Procedure

The shielding effectiveness evaluation was performed per IEEE-299:1997 guidance using the test procedures of ASTM F3057-16:2016.

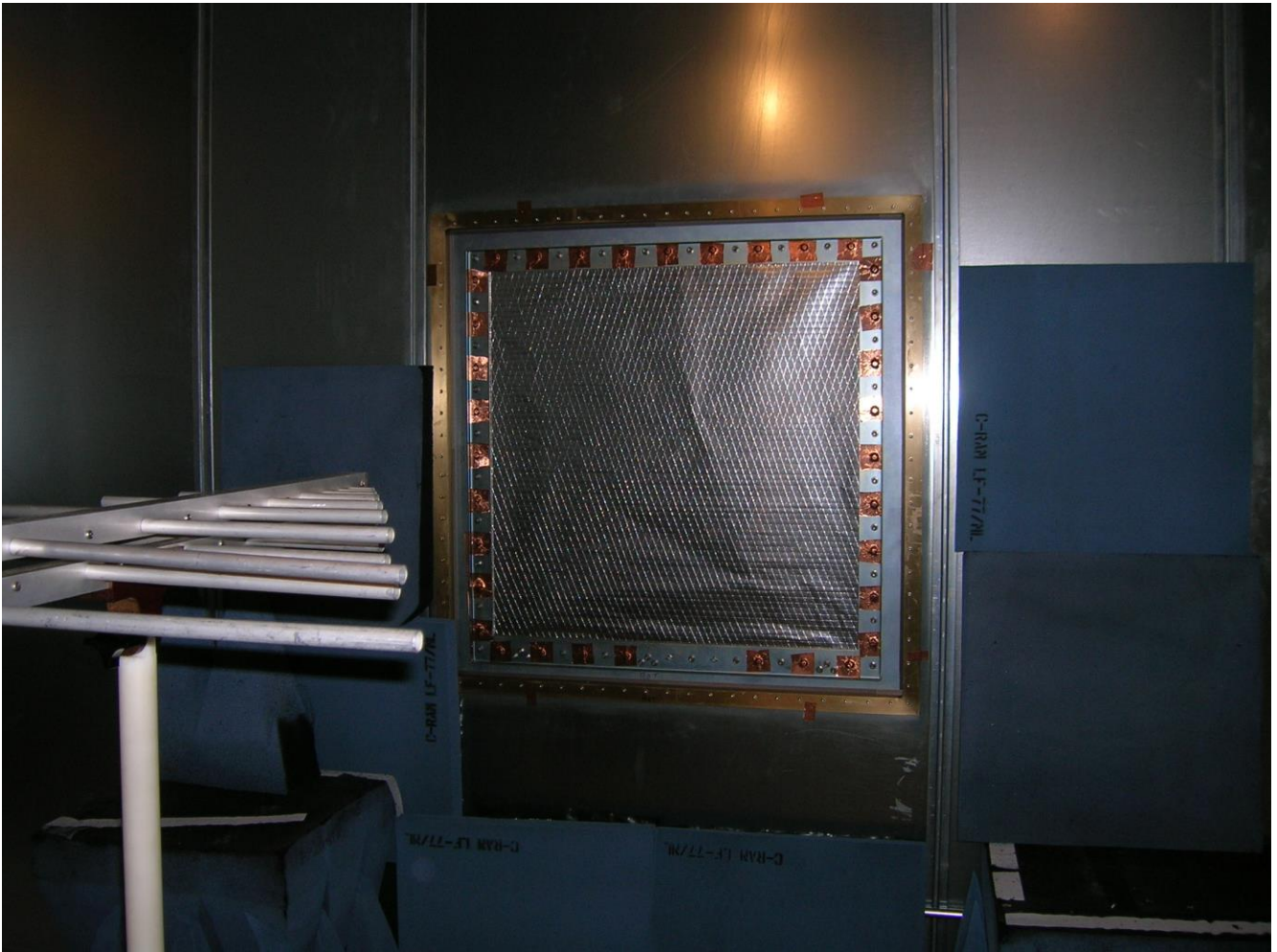


Figure 4-1. Test Setup Photograph Example Transmit Antenna Side (100 MHz – 1 GHz)

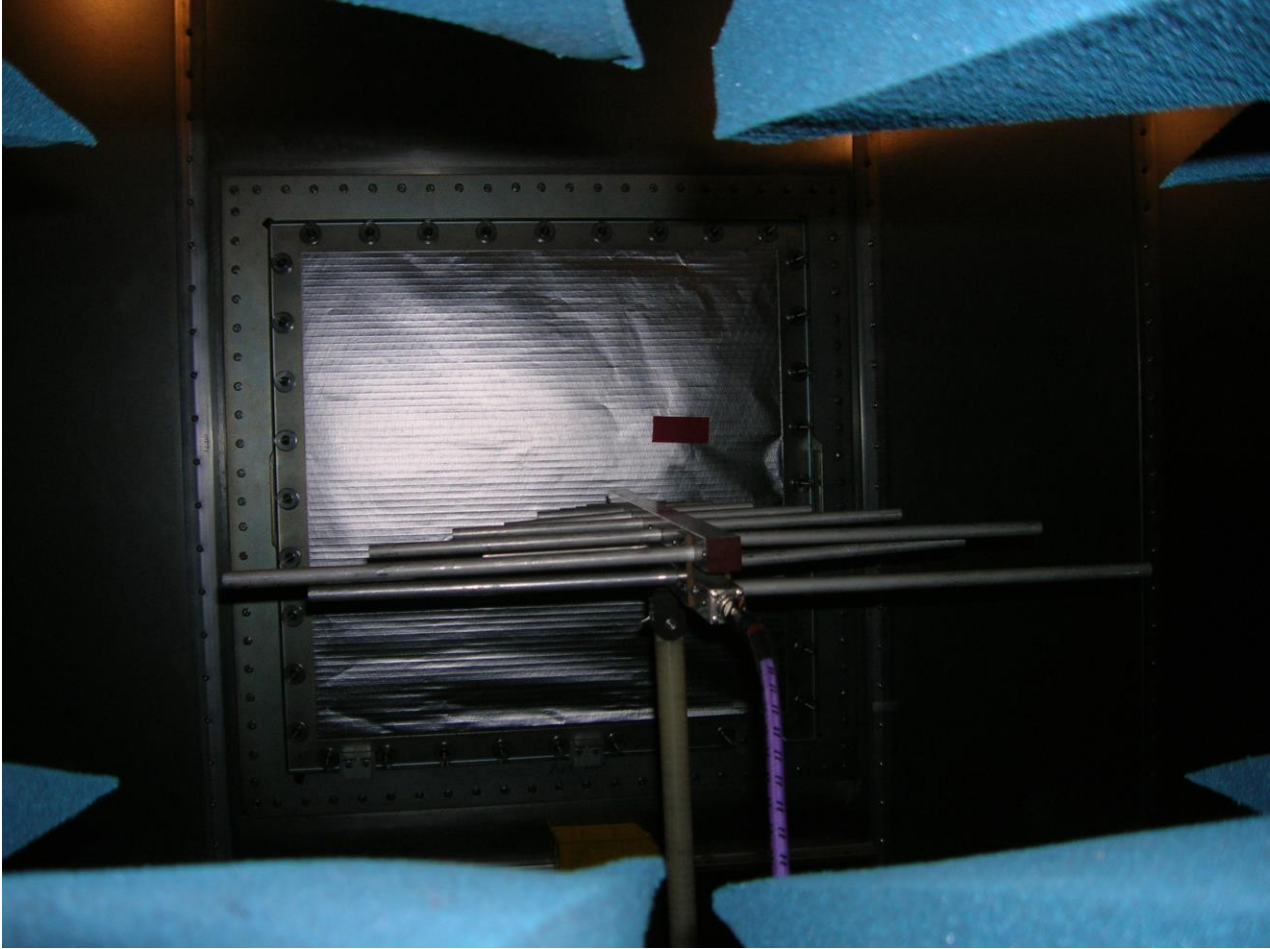


Figure 4-2. Test Setup Photograph Example Receive Antenna Side (100 MHz – 1 GHz)



Figure 4-3. Test Setup Photograph Example Transmit Antenna Side (1 GHz – 18 GHz)

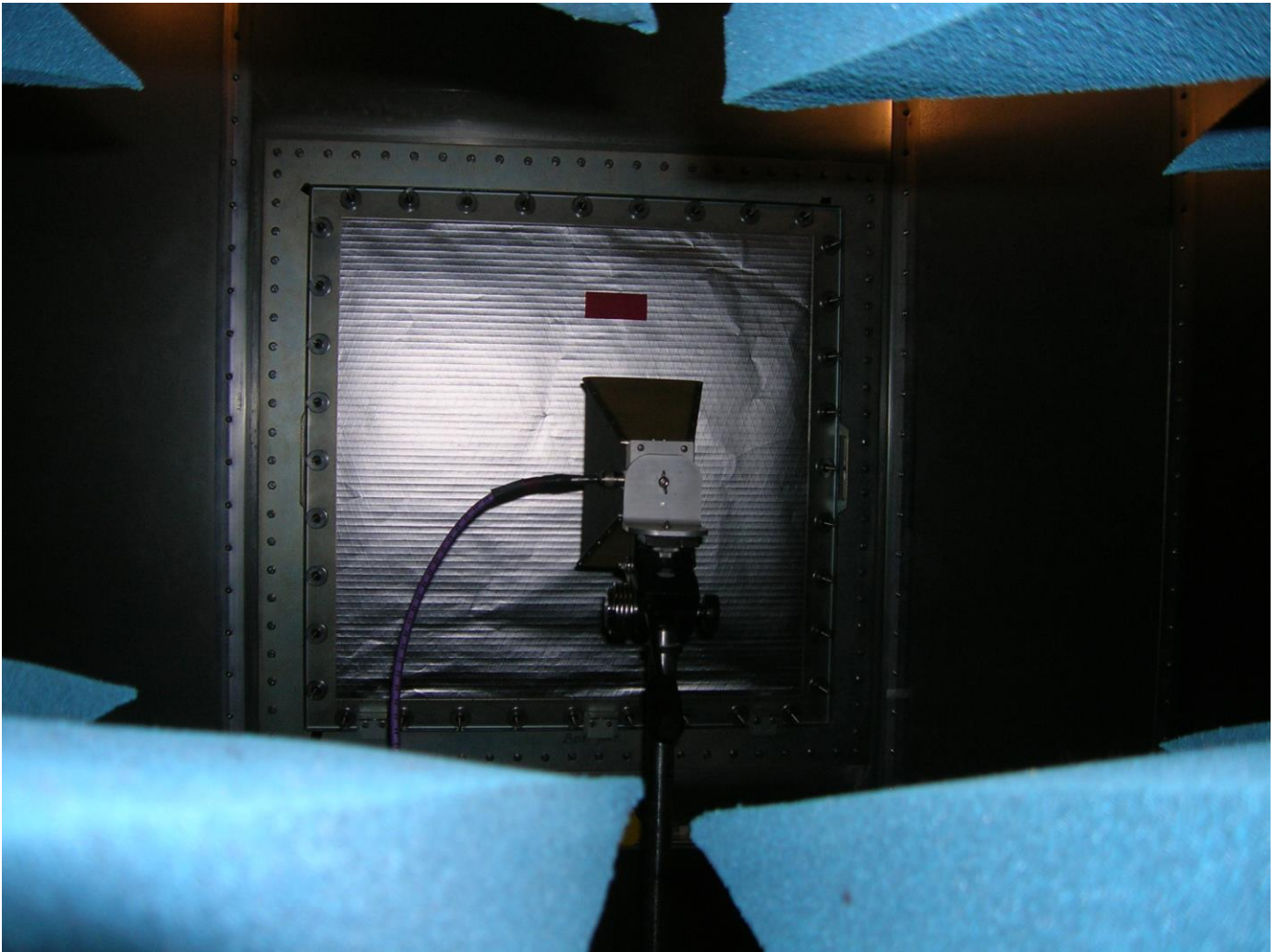


Figure 4-4. Test Setup Photograph Example Receive Antenna Side (1 GHz – 18 GHz)

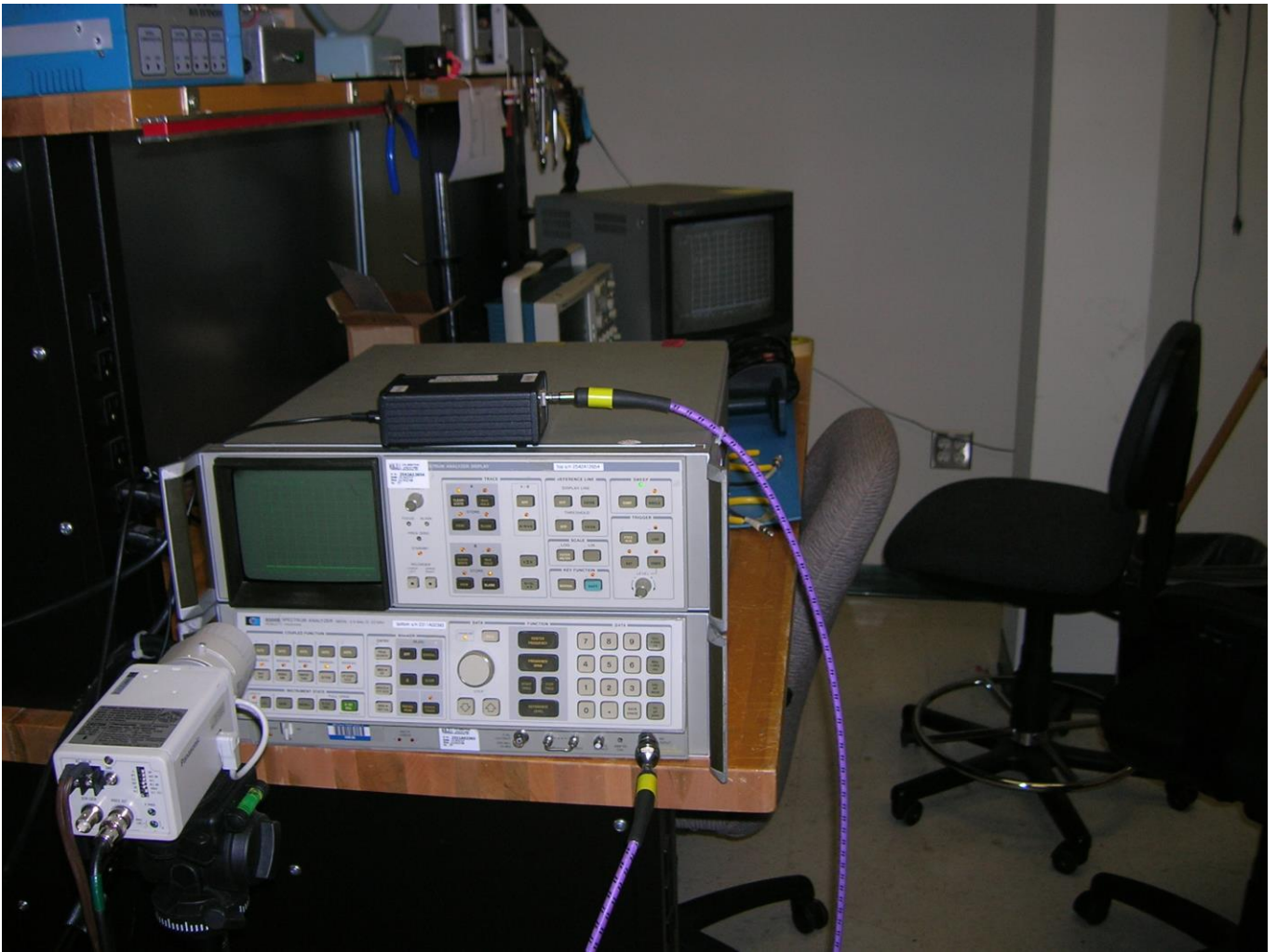


Figure 4-5. Test Setup Photograph of Outside the RF Shielded Test Enclosure (Receive Side)

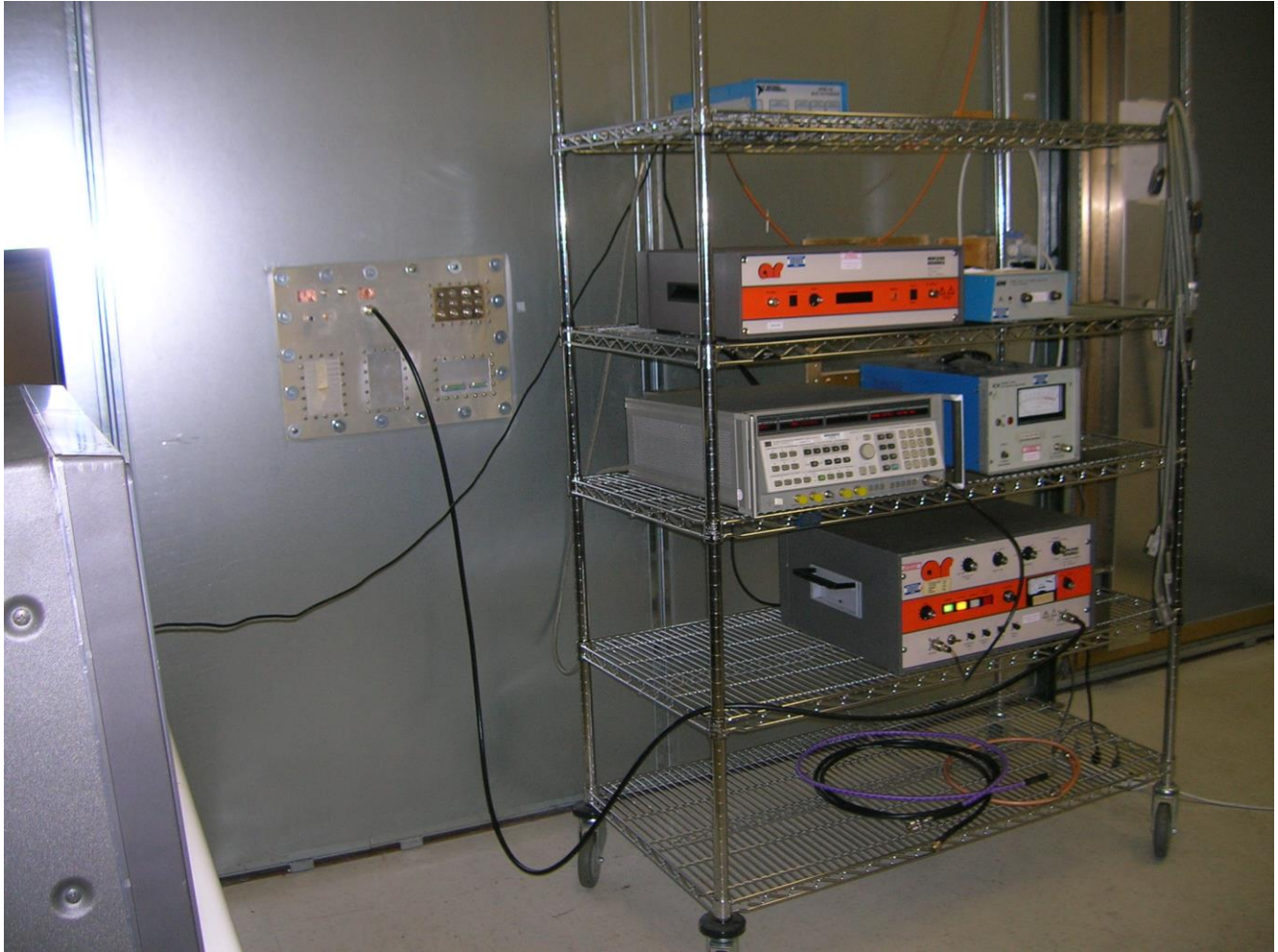


Figure 4-6. Test Setup Photograph of Outside the RF Shielded Test Enclosure (Transmit Side)

5.0 SHIELDING EFFECTIVENESS TEST RESULTS

5.1 Documentation and Presentation of the Test Results

The test results are presented on graphs in an X-Y format in Appendix A. The signal levels plotted are the recorded measurements taken during the shielding effectiveness evaluation as specified in IEEE-299 per the requirements of ASTM F3057-16. The measured attenuation is represented by the Red trace for the amount of attenuation that the test sample offers. Photographs of a typical test setup inside and outside of the RF shielded test enclosure are provided in section 4 of this report.

5.2 Test Deviations

No deviations were required from the test procedures utilized to perform attenuation evaluations of the Fi-FOIL test samples.

5.3 Engineering Statement

Although this data was taken under stringent laboratory conditions and to the best of our knowledge represents accurate data, it must be recognized that shielding effectiveness results may be greatly affected by changes in manufacturing processes, vendor changes and installation practices. Therefore, Advanced Programs Incorporated (API), Cyber Assurance Services, while supporting the accuracy of the data in this report, takes no responsibility for continued compliance of subsequently manufactured products. The material manufacturer must take full responsibility for any field problems, which may arise, and agrees that Advanced Programs Incorporated (API), Cyber Assurance Services, in performing this evaluation, does not assume or undertake any responsibility to the manufacturer or to any other party or parties. It is the sole responsibility of the material manufacturer to ensure that subsequent manufactured products are of the same make and quality.

5.4 Summary of Results

Appendix A Figures A-1 through A-4 contain the test data plots and Table A-1 shows the test equipment list for the Fi-FOIL RF Shield Foil test samples evaluated. The material averaged 75 dB to 80 dB of attenuation.

APPENDIX A

TEST EQUIPMENT LIST AND ATTENUATION TEST RESULTS

Table A-1 Test Equipment List

Sheet 1 of 1

Customer: Fi-FOIL		Job #: TS17-0055		Date: February, 2018	
Test Equipment Name	Model #	Manufacturer	Serial #	Property #	Cal Due Date
Signal Generator	8340B	Hewlett Packard		Wml 0034	2/23/2018
Spectrum Analyzer	8566B	Hewlett Packard	2314A04857 / 2526A01914	00636	5-01-2019
Amplifier	100W1000M1A	Amplifier Research	18934	00833	NCR
Microwave Amplifier	8349B	Hewlett Packard	3205A04030	API CASL1016	NCR
Pre-amp	TTA1800-28	Miteq	1994453	API CASL 1037	Verified On Use
Log Periodic TX	3146	Ailtech	1076	04645	Verified On Use
Log Periodic RX	3146	Eaton	1153	01132	Verified On Use
Double Ridge Horn	3115	EMCO	2686	00873	Verified On Use
Double Ridge Horn	3115	EMCO	9403-4233	01142	Verified On Use
Bus Extender (Local)	GPB-110	National Instruments	9357	API CASL1034	NCR
Bus Extender (Remote)	GPB-110	National Instruments	010155	API CASL1035	NCR
Computer	Optiplex	Dell	29521143073	Desktop #1	NCR

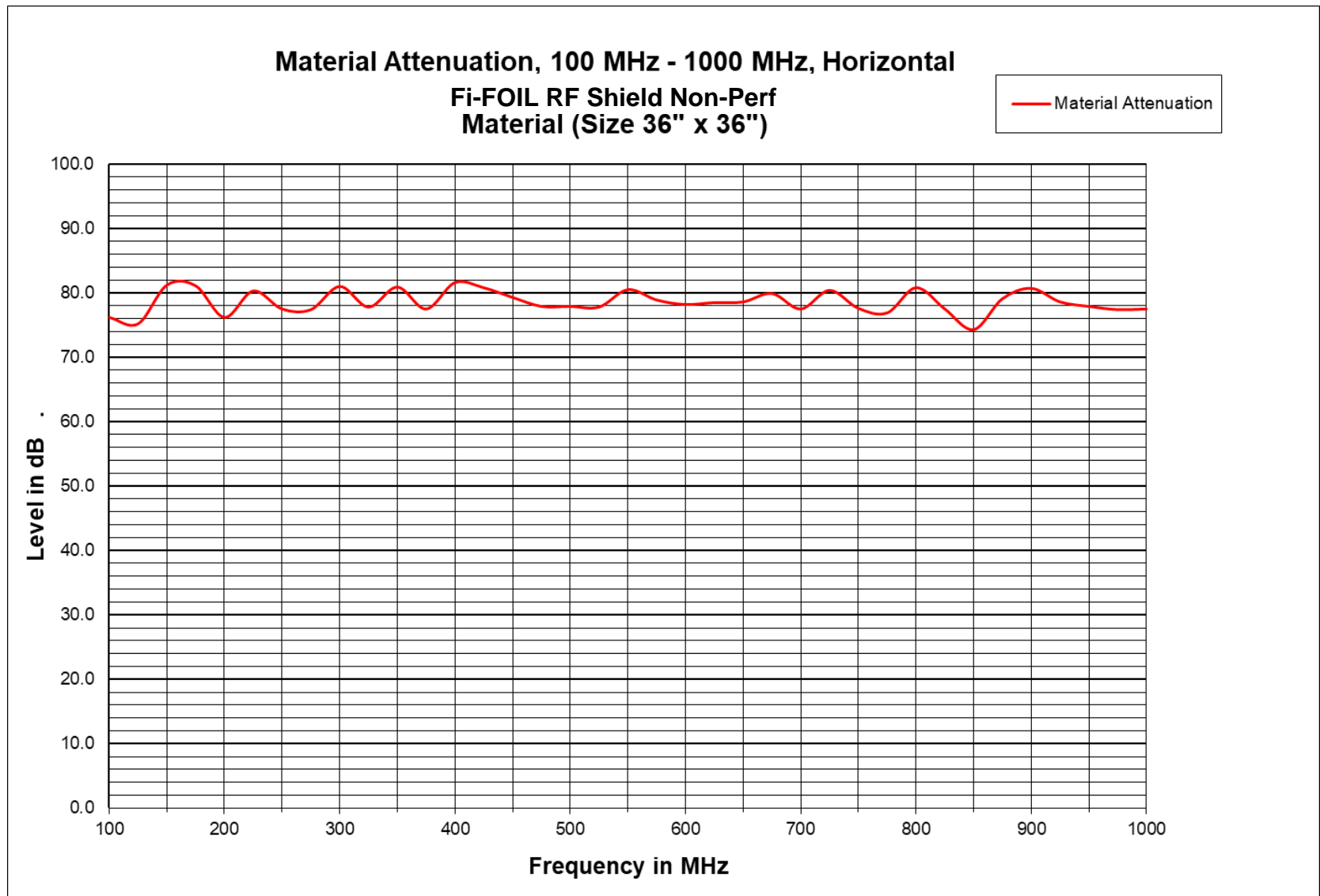


Figure A-1 Fi-FOIL RF Shield (Non-Perforated), 100 MHz to 1 GHz, Antenna Horizontal Test Results.

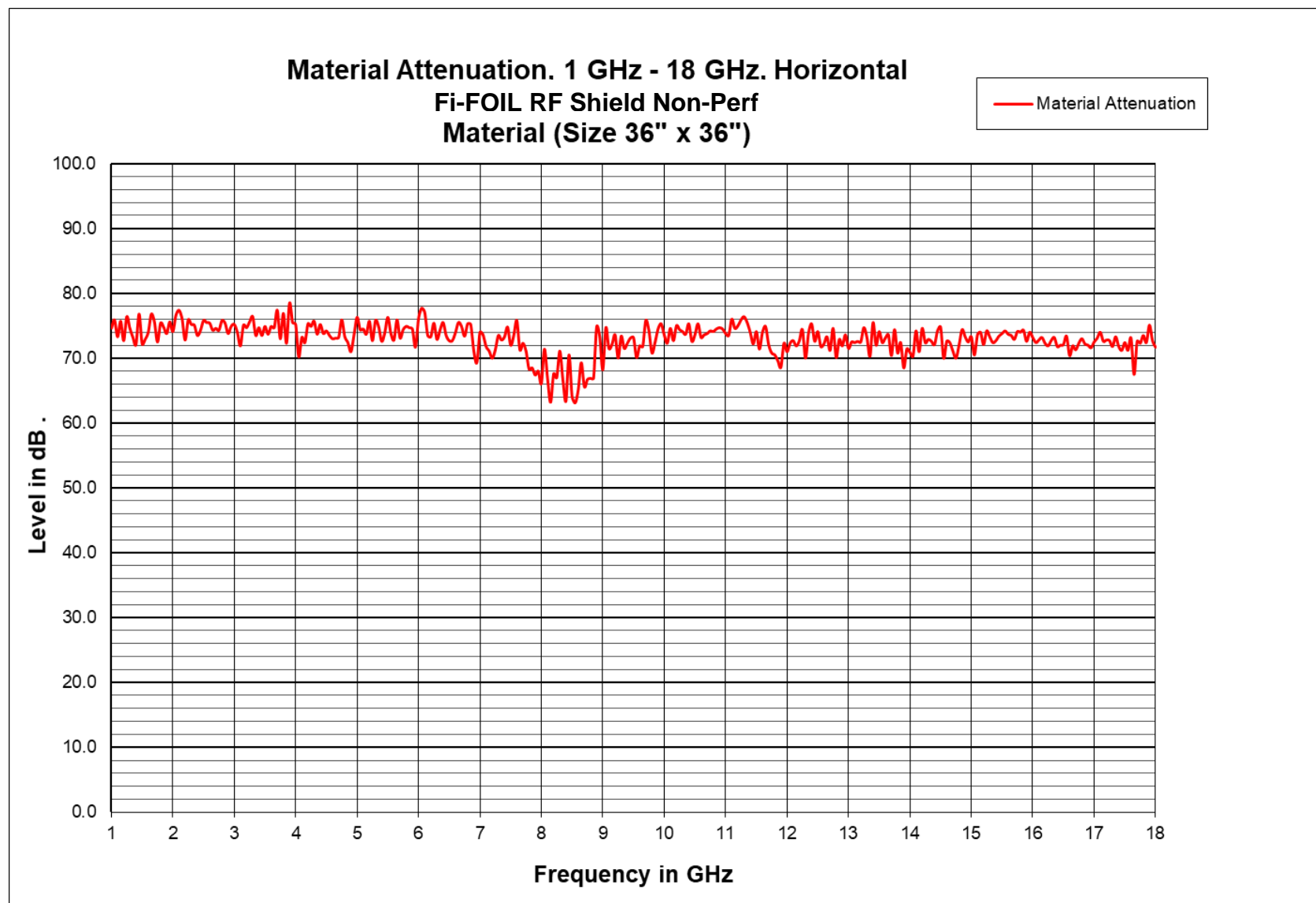


Figure A-2 Fi-FOIL RF Shield (Non-Perforated), 1 GHz to 18 GHz, Antenna Horizontal Test Results.

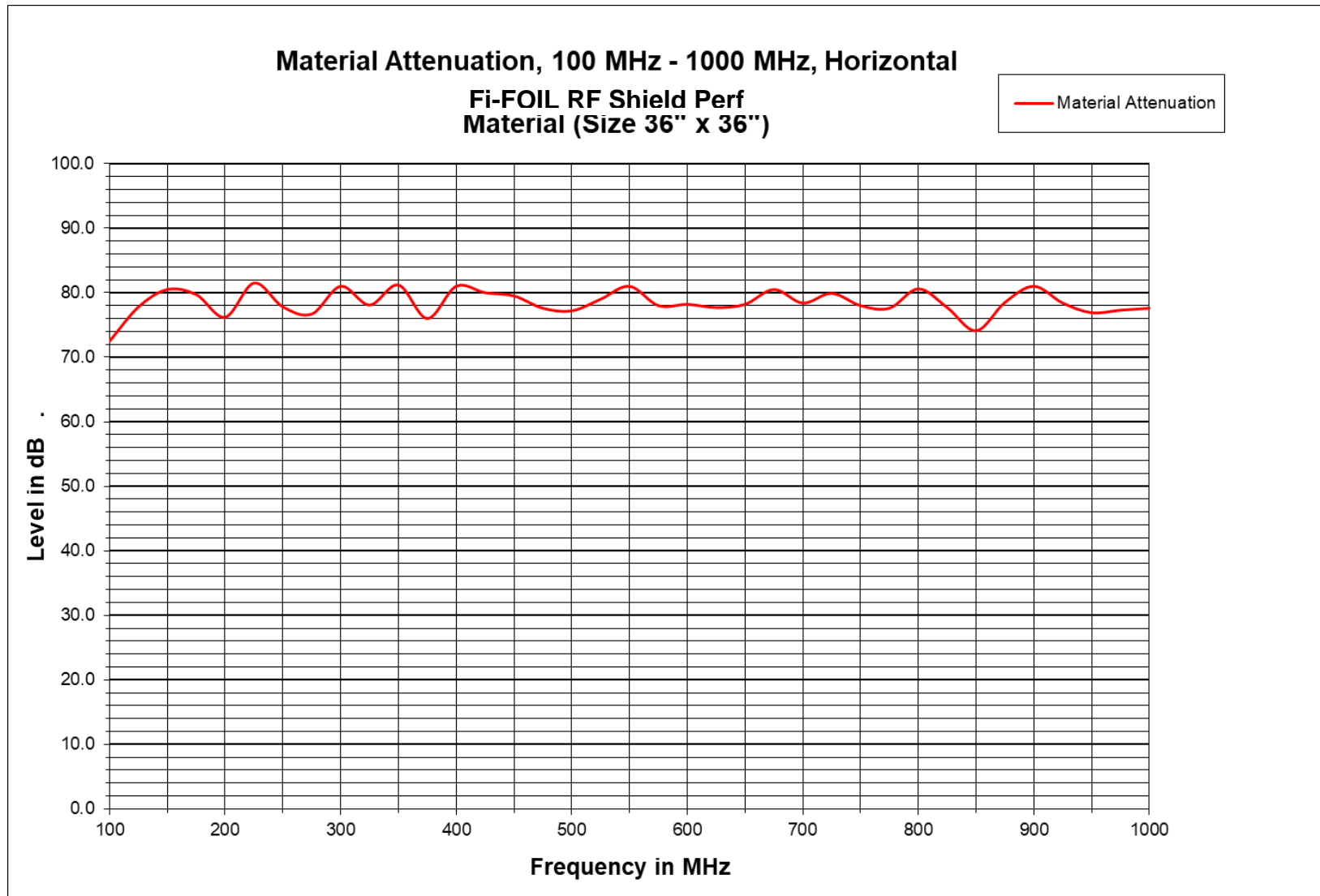


Figure A-3 Fi-FOIL RF Shield (Perforated), 100 MHz to 1 GHz, Antenna Horizontal Test Results.

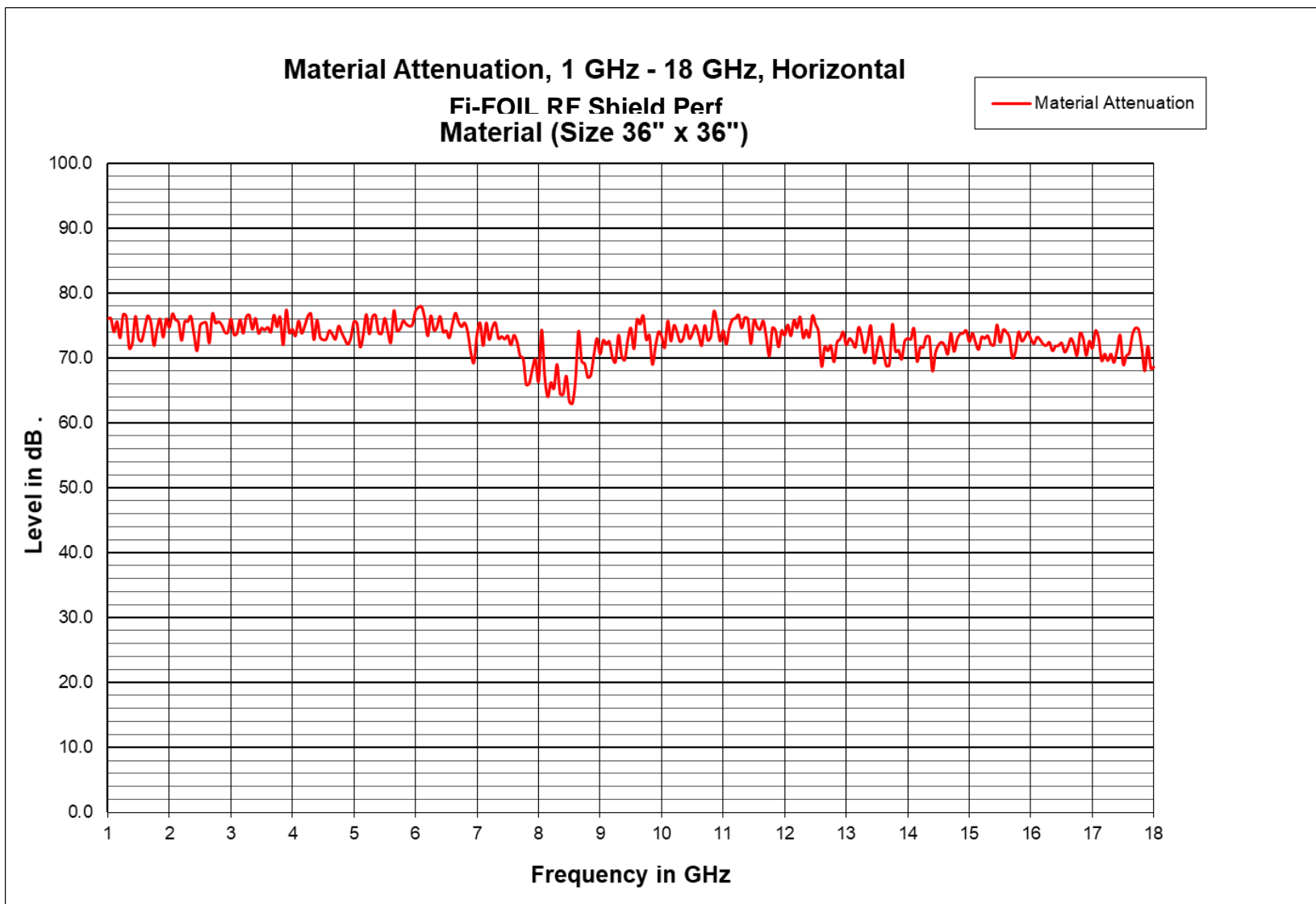


Figure A-4 Fi-FOIL RF Shield (Perforated), 1 GHz to 18 GHz, Antenna Horizontal Test Results.

END OF DOCUMENT