Keystone Compliance, LLC
131 Columbus Inner Belt
New Castle, PA 16101

Phone: 724-657-9940
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MOS Equipment

1901-050ED

SHIELDING EFFECTIVENESS TEST REPORT 1901-050ED REV. A

TEST STANDARDS: MIL-STD-188-125-2

For

MOS EQUIPMENT

201 W MONTECITO ST
SANTA BARBARA, CA 93101

On

FABRIC SAMPLES & FARADAY BAGS (QTY 5)

MODEL NUMBER: N/A; PART NUMBER: N/A; SERIAL NUMBER: N/A

PERFORMED BY: **KEYSTONE COMPLIANCE, LLC.**
131 COLUMBUS INNER BELT
NEW CASTLE, PA 16101

Keystone Compliance, LLC. does hereby certify that all inspections and tests have been performed in accordance with the documents referenced herein with exceptions as noted in this report. The results in this report pertain to the specified equipment tested. This report shall not be reproduced, except in full, without the written authorization of Keystone Compliance, LLC.

Prepared By: _____ **Date:** 3/27/2019
COY PRICE, Technical Writer

Approved By: _____ **Date:** 3/27/2019
TONY MASONE JR., Lab Manager

Approved By: _____ **Date:** 3/27/2019
JOEY SULLIVAN, Quality Manager

DOCUMENT HISTORY

Revision	Issue Date	Description Of Modifications	Revised By	Approved By
N/C	3/21/2019	Initial release	N/A	T.M.
A	3/27/2019	Updated Data	CP	TM

CLIENT INFORMATION

Purchase Order	SOS1250
Quote Number	1901-050ED
EUT Arrival Date	3/5/2019 -- Received in good condition
Company Name	MOS Equipment
Address	201 W Montecito St
City, State Zip	Santa Barbara, CA 93101
Contact Name	Ryan Judy
Email	ryan@mosequipment.com

TEST FACILITY INFORMATION

Test Laboratory	Keystone Compliance, LLC.
Address	131 Columbus Inner Belt
City, State, Zip Code	New Castle, PA 16101
Phone	(724) 657-9940
Fax	724-657-9920
Web Site	www.keystonecompliance.com
Contact Name	Tony Masone Jr.
Title	Lab Manager
E-Mail Address	Tonyjr@keystonecompliance.com

TEST PROGRAM INFORMATION

Test Personnel	Travis Gennaro – EMC Test Technician
Test Title & Test Dates	Shielding Effectiveness – March 11, 2019 to March 15, 2019

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

This report documents the results of the EMC tests performed on the Fabric Samples & Faraday Bags (Qty 5), Model Number: N/A; Part Number: N/A; Serial Number: N/A, submitted by MOS Equipment

The EMC test programs described herein were performed in accordance with the applicable requirements of MIL-STD-188-125-2.

All test data is included in Section 3 of this document.

All tests performed at Keystone Compliance New Castle, PA EMC test facility. All tests were performed using the test set-ups of the relevant standard for tests performed in laboratory conditions.

ACRONYMS AND ABBREVIATIONS

EMC – Electromagnetic Compatibility

EMI – Electromagnetic Interference

EUT – Equipment Under Test

M/N – Model Number

P/N – Part Number

S/N – Serial Number

Vac – Voltage Alternating Current

DC – Direct Current

AM – Amplitude Modulation

dB – Decibel

deg – Degree

H/V – Horizontal or Vertical Polarity

m – Meters

cm – Centimeter

V/m – Volts per meter

dBuV/m – Decibel microvolts per meter

kV – Kilovolt

Hz – Hertz

kHz – Kilohertz

MHz – Megahertz

GHz – Gigahertz

pF – Picofarad

Ω – Ohm

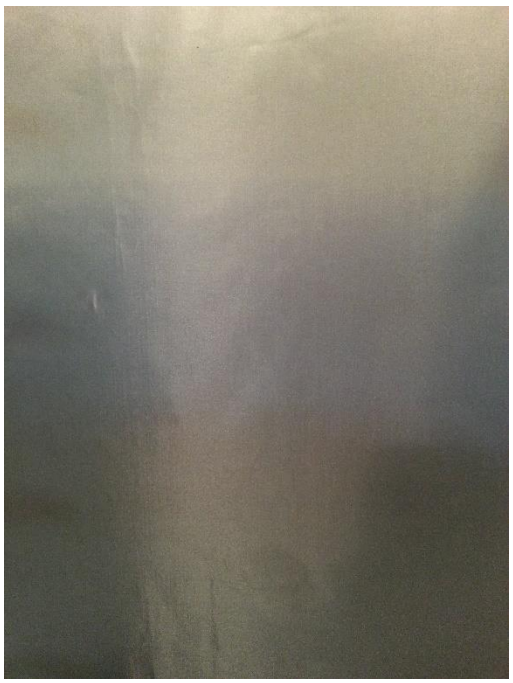
QP – Quasi-Peak

N/A – Not Applicable

CONFIGURATION

Testing performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations, and settings used to complete the evaluation. The actual test parameters specified in the test data; this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation, indicated in the test data.

EUT		
Description	Manufacturer	
Fabric Samples & Faraday Bags (Qty 5)	**MOS Equipment**	
Model Number	Part Number	Serial Number
N/A	**N/A**	**N/A**



EUT
Fabric

	**EUT** **Small Bag**

	**EUT** **Large Bag**

SUMMARY OF TESTS PERFORMED & RESULTS

TABLE 1 TEST'S PERFORMED & RESULTS

Report Paragraph	Test Description	Specification	Notes	Results
MIL-STD-188-125-2				
3.1	Shielding Effectiveness	MIL-STD-188-125-2	Frequency Range: 10kHz-40GHz (Extended Frequency Range) Test Limit: See Figure 4 "Minimum HEMP shielding effectiveness requirements (measured in accordance with procedures of Appendix A)." Goal Zero to provide 5/8" hole in bags for "N-Type" coaxial feedthrough. "N-Type" coaxial feedthrough to be provided by Keystone Compliance.	Compliant

SECTION 1 – TEST CONDITIONS AND EQUIPMENT

1.1 INSTRUMENTATION AND EQUIPMENT

Measuring and test equipment, utilized in the performance of these tests, was calibrated in accordance with ANSI/NCSL Z540-3-2006, by Keystone Compliance, LLC or a commercial facility, utilizing reference standards (or interim standards) whose calibrations have been certified as being traceable to the National Institute of Standards & Technology (NIST). All reference standards utilized in the above calibration system are supported by certificates, reports, or data sheets attesting to the date, accuracy, and conditions under which the results furnished were obtained. All subordinate standards, measuring and test equipment are supported by like data when such information is essential to achieve the accuracy control required by the procedure.

Keystone Compliance, LLC attests that the commercial sources providing calibration services on the above-referenced equipment, other than the NIST Standards are in fact capable of performing the required services to the satisfaction of Keystone Compliance, LLC Quality Assurance. Certifications of all calibrations performed are retained on file in the Keystone Compliance, LLC Quality Assurance Department, and are available for inspection upon request by customer representatives.

The test equipment utilized during this test program is listed on individual Test Equipment Logs located in Section 3 of this document.

1.2 TOLERANCES

All test conditions were maintained within all applicable specified tolerances.

SECTION 2 – REFERENCES

2.1 APPLICABLE SPECIFICATIONS

Reference Specification Title	**MIL-STD-188-125-2** **High-Altitude Electromagnetic Pulse (Hemp) Protection for Ground-Based C4I Facilities Performing Critical, Time-Urgent Missions - Part 2 - Transportable Systems**
Calibration Information	**ANSI/NCSL Z540-3-2006** **Calibration Laboratories and Measuring Test Equipment— General Requirements**

SECTION 3 – TEST DESCRIPTIONS, TEST EQUIPMENT, TEST DATA, & TEST SETUP PHOTOGRAPHS

3.1 SHIELDING EFFECTIVENESS TEST

a) The Shielding Effectiveness test requirements for the Fabric Samples & Faraday Bags (Qty 5) are specified in MIL-STD-188-125-2.

b) The Shielding Effectiveness test description for the Fabric Samples & Faraday Bags (Qty 5) is located in Paragraph 3.1.1 of this document.

c) The Shielding Effectiveness test equipment used to test the Fabric Samples & Faraday Bags (Qty 5) is located in Paragraph 3.1.2 of this document.

d) All recorded test data for the Shielding Effectiveness test on the Fabric Samples & Faraday Bags (Qty 5) is located in Paragraph 3.1.3 of this document.

e) The Shielding Effectiveness test setup photographs for the Fabric Samples & Faraday Bags (Qty 5) are located in Paragraph 3.1.4 of this document.

3.1.1 SHIELDING EFFECTIVENESS TEST DESCRIPTION

Test Description
Using the configuration(s) noted within this report, multiple shielding effectiveness tests were performed. The frequency range investigated is also noted in this report.

Sample Calculation
Shielding Effectiveness: "Open Bulkhead" measurement – Test Screen Measurement

Measurement Bandwidths					
Start Frequency:	10kHz	Stop Frequency:	40GHz	Step Size:	10/decade

3.1.2 SHIELDING EFFECTIVENESS TEST EQUIPMENT LOG

Equipment Log	
Customer:	**MOS Equipment**
Date:	**3/11/19**
Test Engineer:	**T. Gennaro**

Test Equipment					
Asset No.	Description	Manufacturer	Model	Serial No.	Cal. Due
EB036	Spectrum Analyzer	Hewlett Packard	8564E	3728A00854	5/1/2019
EF000	Signal Generator	Hewlett Packard	8648C	3847U02762	1/21/2020
EF125	Signal Generator	Rohde & Schwarz	SMP04	DE33813	8/7/2019
EG027	RF Amplifier	Amplifier Research	100A250A	310760	UWCE
EG001	RF Amplifier	Amplifier Research	100W1000M3	16400	UWCE
EG007	RF Amplifier	Hewlett Packard	8349B	2644A01939	UWCE
EG058	Pre-Amplifier	Hewlett Packard	8447A-custom	2123a05845	6/6/2020
EG024	Pre-Amplifier	Keystone Compliance	KCM106	8-30-2010	4/9/2019
EG003	Pre-Amplifier	Keystone Compliance	PA-1	0002	3/31/2019
EE063	Transmit 12" Loop Antenna	AH Systems	SAS-564	380	UWCE
EE070	Active 12" Loop Antenna	AH Systems	SAS-563B	506	UWCE
EE012	Biconical Antenna	EMCO	3109	9505-2910	UWCE
EE066	Biconical Antenna	AH System	SAS-540	786	5/1/2020
EE002	Log Periodic Antenna	EMCO	3146	2188	UWCE
EE060	Log Periodic Antenna	Electrometics	EM6950	983	7/19/2020
EE046	DRG Horn Antenna	EMCO	3115	2436	UWCE
EE009	DRG Horn Antenna	A.H. Systems, Inc.	SAS-200/571	175	1/23/2020
EE054	Horn Antenna	Antenna Research Assoc.	MWH-2640/B	1025	UWCE
EE017	Horn Antenna	ETS Lindgren	3116	00026390	1/31/2020

UWCE: Used With Calibrated Equipment

3.1.3 SHIELDING EFFECTIVENESS TEST DATA

Shielding Effectiveness Data Sheet (SMALL BAG)					
Customer:	**MOS Equipment**				
Date:	**3/11/19**			Test Engineer:	**T. Gennaro**
Config. #:	**1**	Power:	**N/A**	Job Site:	**Keystone Compliance**
Test Specifications					
Test Spec.:	**MIL-STD-188-125-2**				

Test Data

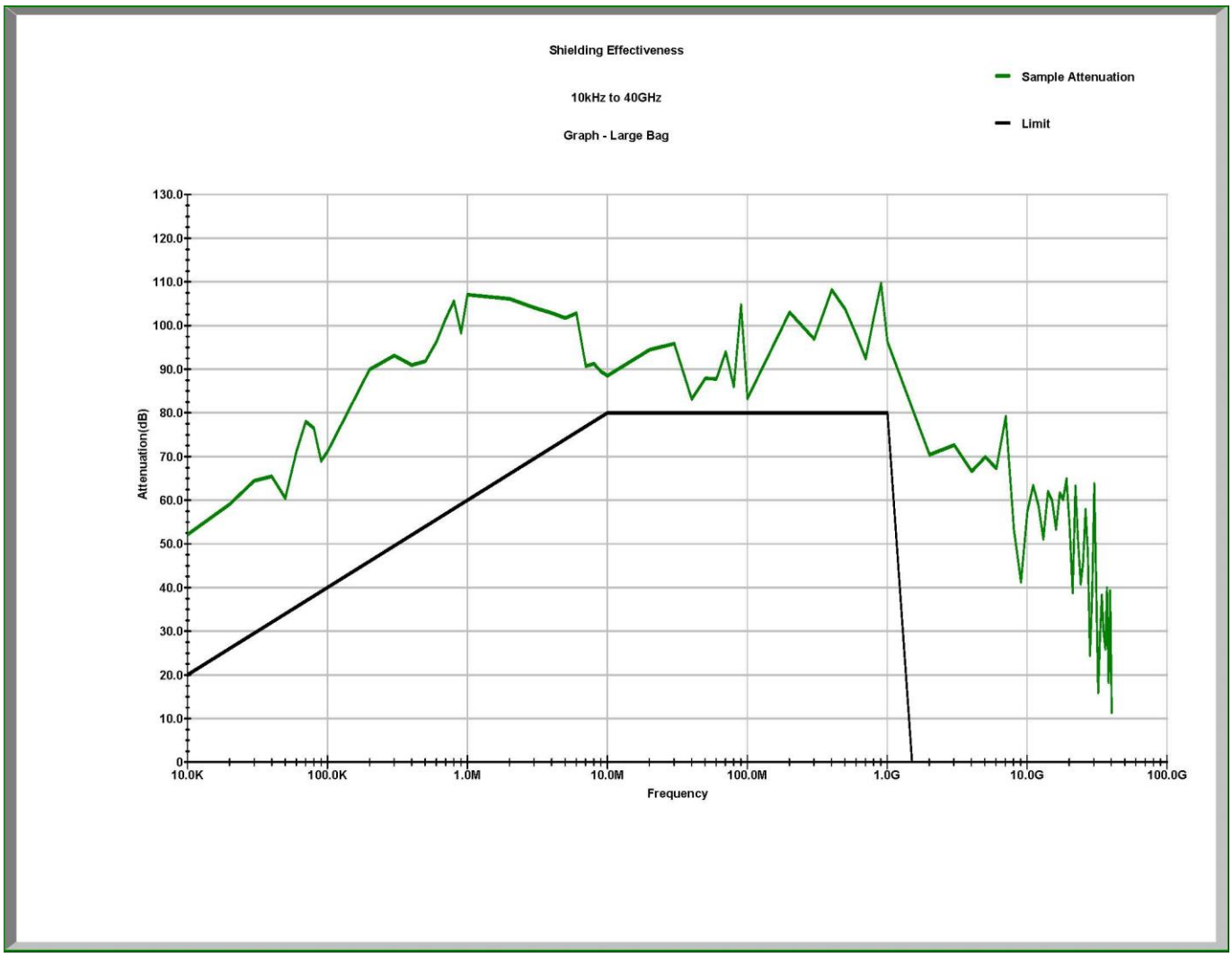
Test Parameters					
Start Frequency:	**10kHz**	Stop Frequency:	**40GHz**	Test Distance:	**0.2 meters**
EUT Operating Modes					
N/A					
Comments					
Small Bag					
Deviations From Test Standard					
None					
Results					
Compliant					


Shielding Effectiveness
10kHz to 40GHz
Graph - Small Bag
Sample Attenuation
Limit
Attenuation(dB)
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
10.0K
100.0K
1.0M
10.0M
100.0M
1.0G
10.0G
100.0G
Frequency

Shielding Effectiveness Data Sheet (LARGE BAG)					
Customer:	**MOS Equipment**				
Date:	**3/11/19**			Test Engineer:	**T. Gennaro**
Config. #:	**1**	Power:	**N/A**	Job Site:	**Keystone Compliance**
Test Specifications					
Test Spec.:	**MIL-STD-188-125-2**				

Test Data

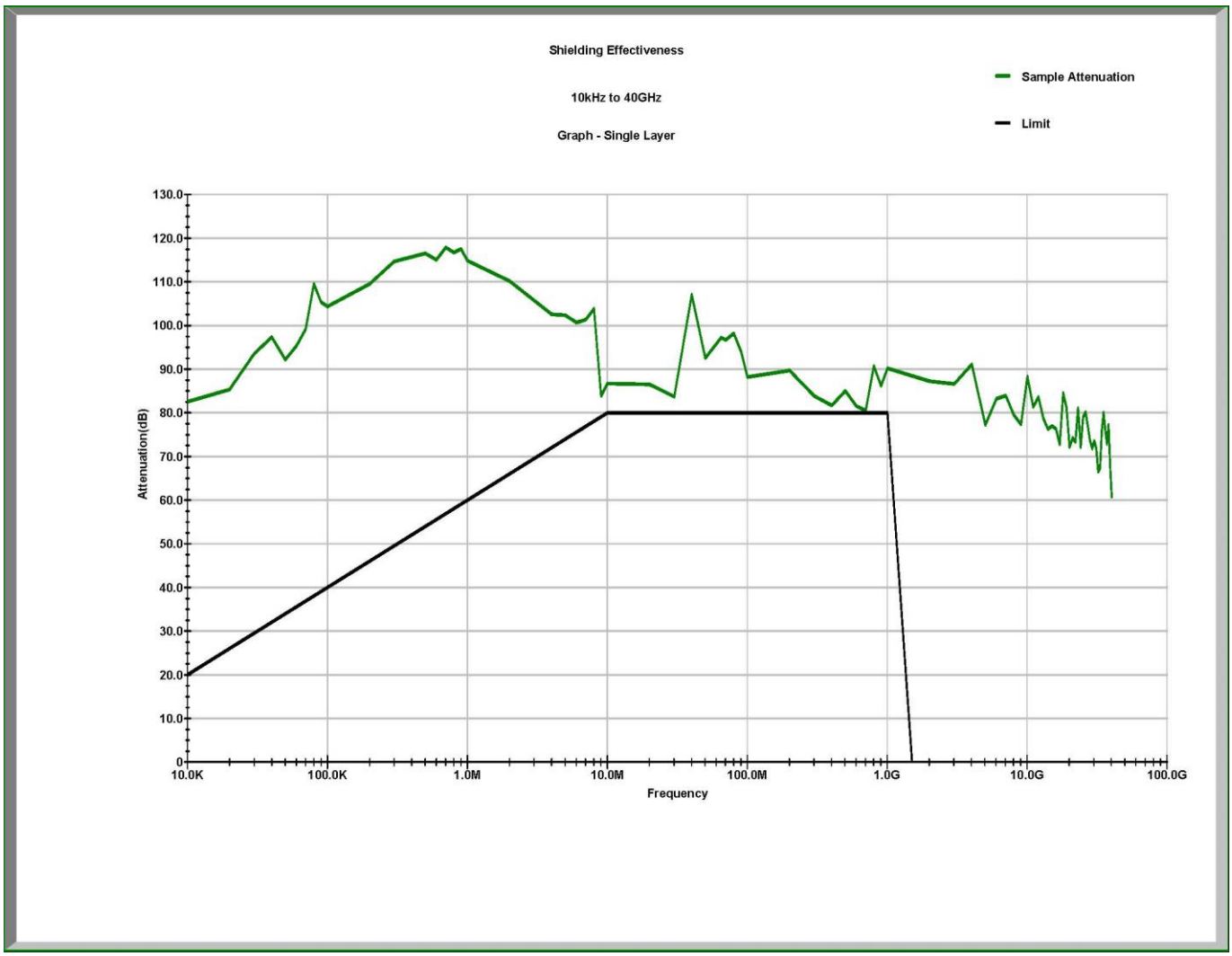
Test Parameters					
Start Frequency:	**10kHz**	Stop Frequency:	**40GHz**	Test Distance:	**0.2 meters**
EUT Operating Modes					
N/A					
Comments					
Large Bag					
Deviations From Test Standard					
None					
Results					
Compliant					


Shielding Effectiveness
10kHz to 40GHz
Graph - Large Bag
Sample Attenuation
Limit
Attenuation(dB)
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
10.0K
100.0K
1.0M
10.0M
100.0M
1.0G
10.0G
100.0G
Frequency

Shielding Effectiveness Data Sheet (SINGLE LAYER)					
Customer:	MOS Equipment				
Date:	3/11/19			Test Engineer:	T. Gennaro
Config. #:	1	Power:	N/A	Job Site:	Keystone Compliance
Test Specifications					
Test Spec.:	MIL-STD-188-125-2				

Test Data

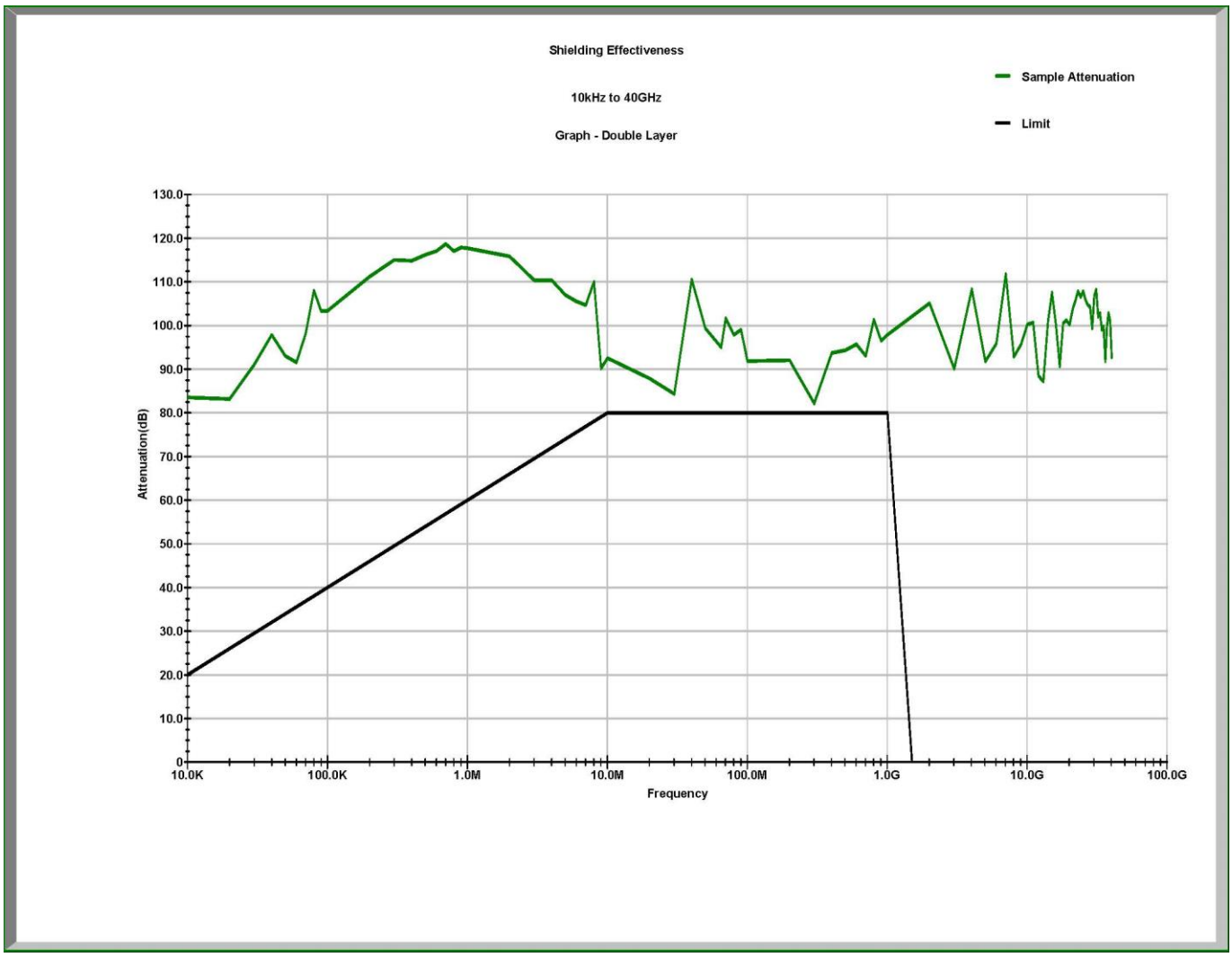
Test Parameters					
Start Frequency:	10kHz	Stop Frequency:	40GHz	Test Distance:	2 meters
EUT Operating Modes					
N/A					
Comments					
None					
Deviations From Test Standard					
None					
Results					
Compliant					


Shielding Effectiveness
10kHz to 40GHz
Graph - Single Layer
Sample Attenuation
Limit
Attenuation(dB)
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
10.0K
100.0K
1.0M
10.0M
100.0M
1.0G
10.0G
100.0G
Frequency

Shielding Effectiveness Data Sheet (DOUBLE LAYER)					
Customer:	**MOS Equipment**				
Date:	**3/11/19**			Test Engineer:	**T. Gennaro**
Config. #:	**1**	Power:	**N/A**	Job Site:	**Keystone Compliance**
Test Specifications					
Test Spec.:	**MIL-STD-188-125-2**				

Test Data

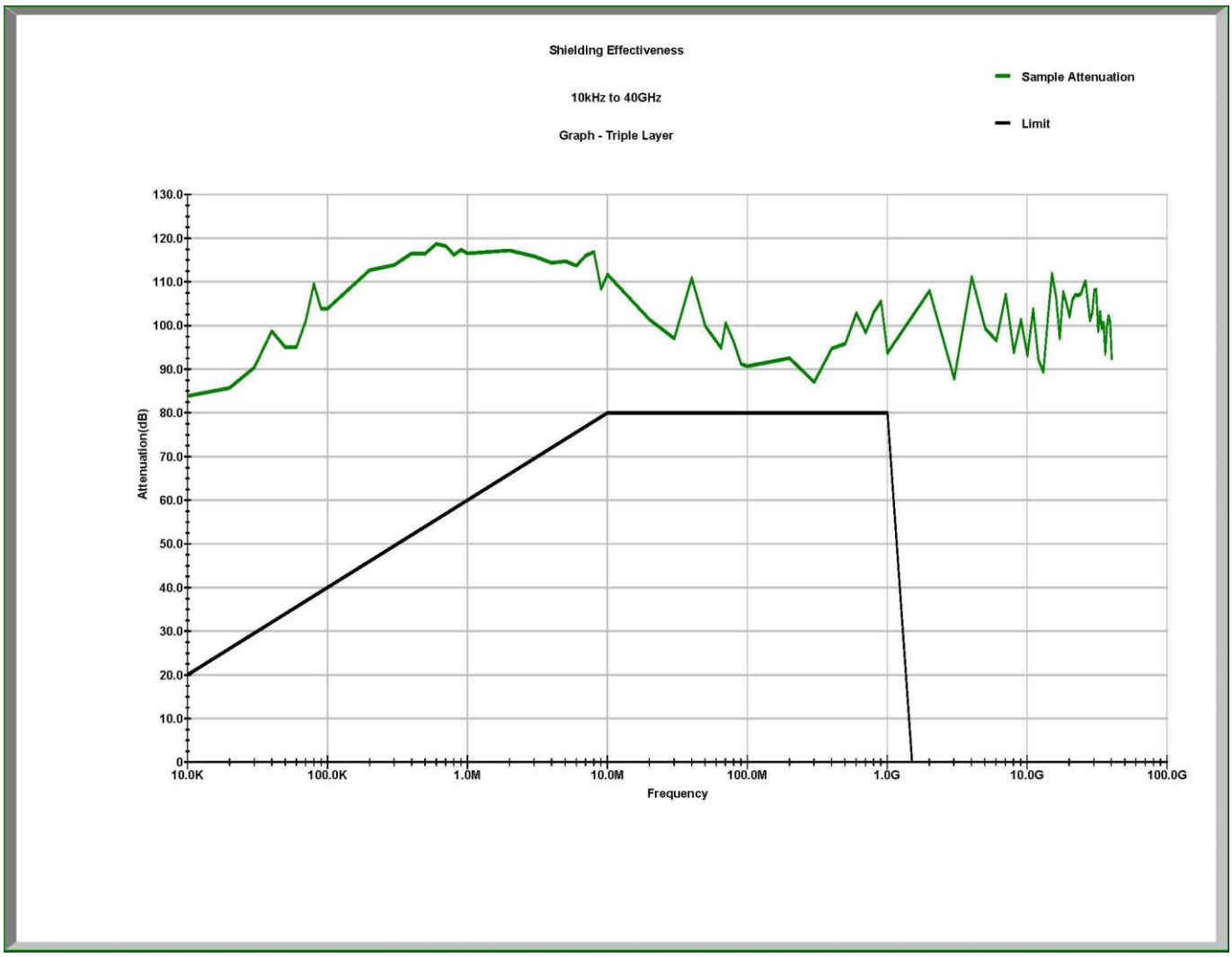
Test Parameters					
Start Frequency:	**10kHz**	Stop Frequency:	**40GHz**	Test Distance:	**2 meters**
EUT Operating Modes					
N/A					
Comments					
None					
Deviations From Test Standard					
None					
Results					
Compliant					


Shielding Effectiveness
10kHz to 40GHz
Graph - Double Layer
Sample Attenuation
Limit
Attenuation(dB)
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
10.0K
100.0K
1.0M
10.0M
100.0M
1.0G
10.0G
100.0G
Frequency

Shielding Effectiveness Data Sheet (TRIPLE LAYER)					
Customer:	**MOS Equipment**				
Date:	**3/11/19**			Test Engineer:	**T. Gennaro**
Config. #:	**1**	Power:	**N/A**	Job Site:	**Keystone Compliance**
Test Specifications					
Test Spec.:	**MIL-STD-188-125-2**				

Test Data

Test Parameters					
Start Frequency:	**10kHz**	Stop Frequency:	**40GHz**	Test Distance:	**2 meters**
EUT Operating Modes					
N/A					
Comments					
None					
Deviations From Test Standard					
None					
Results					
Compliant					


Shielding Effectiveness
10kHz to 40GHz
Graph - Triple Layer
Sample Attenuation
Limit
Attenuation(dB)
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
10.0K
100.0K
1.0M
10.0M
100.0M
1.0G
10.0G
100.0G
Frequency

Shielding Effectiveness					
	Attenuation (dB)				
Frequency	Small Bag	Large Bag	Single Layer	Double Layer	Triple Layer
10kHz	35.29	52.12	82.50	83.50	83.84
20kHz	43.30	59.01	85.33	83.16	85.66
30kHz	47.74	64.42	93.50	91.00	90.33
40kHz	45.41	65.41	97.33	97.83	98.66
50kHz	43.03	60.44	92.16	93.00	95.00
60kHz	58.37	71.09	95.33	91.50	95.00
70kHz	58.30	77.97	99.16	98.16	101.00
80kHz	57.64	76.47	109.50	108.00	109.50
90kHz	52.80	68.97	105.33	103.33	103.83
100kHz	56.07	71.07	104.33	103.33	103.83
200kHz	72.21	89.87	109.50	111.16	112.66
300kHz	73.77	93.10	114.66	115.00	113.83
400kHz	74.11	90.94	115.67	114.84	116.50
500kHz	73.61	91.77	116.50	116.17	116.50
600kHz	77.20	96.21	115.00	117.00	118.66
700kHz	84.37	101.54	117.83	118.66	118.16
800kHz	85.53	105.54	116.67	117.00	116.17
900kHz	82.87	98.37	117.50	117.83	117.33
1MHz	81.37	107.04	114.83	117.67	116.50
2MHz	99.74	106.08	110.16	115.83	117.16
3MHz	101.04	104.04	105.66	110.33	115.83
4MHz	96.80	102.81	102.50	110.33	114.33
5MHz	98.34	101.68	102.34	107.00	114.67
6MHz	100.94	102.77	100.67	105.50	113.67
7MHz	95.37	90.71	101.33	104.66	116.00
8MHz	85.21	91.20	103.83	110.00	116.83
9MHz	81.38	89.37	83.84	90.17	108.34
10MHz	85.30	88.47	86.67	92.50	111.67
20MHz	90.07	94.41	86.50	87.84	101.34
30MHz	92.84	95.83	83.67	84.34	97.00
40MHz	87.84	83.16	107.00	110.50	110.83
50MHz	84.19	87.87	92.50	99.33	99.83
60MHz	96.13	87.75	97.17	95.00	94.83
70MHz	95.29	93.97	96.67	101.67	100.50
80MHz	87.53	86.03	98.16	97.83	96.16
90MHz	83.80	104.63	94.00	99.00	91.16
100MHz	87.30	83.29	88.16	91.83	90.67
200MHz	81.70	103.03	89.67	92.00	92.50
300MHz	105.50	96.84	83.84	82.17	87.00
400MHz	102.30	108.14	81.66	93.67	94.67
500MHz	117.17	103.67	84.99	94.33	95.83
600MHz	104.27	97.76	81.50	95.67	102.83
700MHz	105.60	92.43	80.50	93.00	98.34

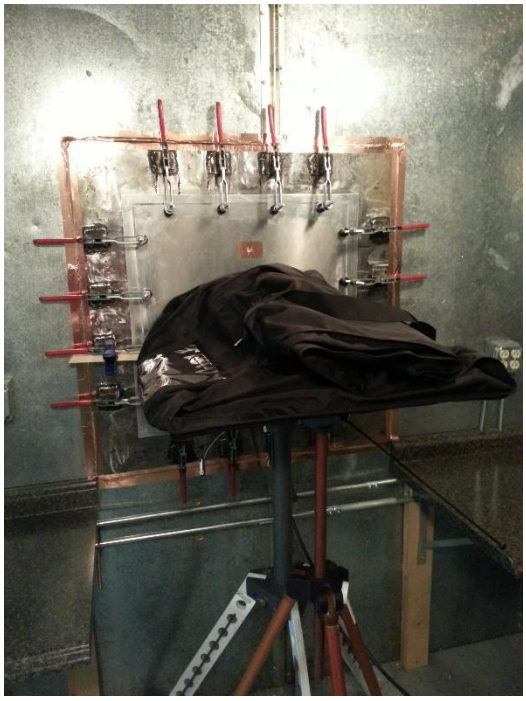
Shielding Effectiveness					
	Attenuation (dB)				
Frequency	Small Bag	Large Bag	Single Layer	Double Layer	Triple Layer
800MHz	104.84	101.84	90.67	101.34	103.00
900MHz	111.06	109.57	86.17	96.50	105.50
1GHz	107.20	96.20	90.17	97.83	93.67
2GHz	103.74	70.40	87.23	105.07	107.90
3GHz	104.93	72.59	86.59	90.09	87.76
4GHz	101.23	66.57	91.06	108.24	111.07
5GHz	94.40	69.90	77.23	91.74	99.24
6GHz	101.03	67.20	83.20	95.86	96.53
7GHz	85.26	79.10	83.93	111.76	107.10
8GHz	83.00	53.33	79.50	92.83	93.83
9GHz	80.30	41.30	77.30	95.63	101.30
10GHz	91.77	57.43	88.27	100.27	93.11
11GHz	96.83	63.33	81.34	100.67	103.67
12GHz	86.60	58.77	83.60	88.43	92.10
13GHz	72.16	51.16	78.67	87.17	89.34
14GHz	76.60	61.94	76.26	100.76	101.93
15GHz	69.99	60.00	77.00	107.50	111.83
16GHz	71.44	53.43	76.26	99.93	106.60
17GHz	57.60	61.59	72.76	90.60	97.10
18GHz	51.16	60.17	84.50	100.50	107.67
19GHz	87.34	64.84	81.17	101.17	105.00
20GHz	58.83	54.33	72.17	100.17	102.00
21GHz	76.34	38.84	74.17	103.67	106.00
22GHz	61.50	63.16	73.34	105.67	107.00
23GHz	68.50	50.67	81.00	107.84	106.84
24GHz	69.66	40.83	72.17	106.50	107.16
25GHz	64.50	45.82	78.99	107.83	108.83
26GHz	64.16	57.82	80.16	105.83	110.16
27GHz	69.16	47.99	76.82	104.66	105.32
28GHz	65.83	24.50	73.66	104.33	101.16
29GHz	74.16	38.99	71.83	99.33	102.83
30GHz	56.16	63.66	73.49	106.83	107.99
31GHz	75.17	40.17	71.84	108.17	108.17
32GHz	58.99	16.00	66.50	102.00	98.66
33GHz	44.16	28.83	67.33	102.83	103.16
34GHz	56.00	38.16	75.83	99.00	99.33
35GHz	69.00	29.83	80.00	99.83	100.66
36GHz	55.51	26.00	75.84	91.84	93.51
37GHz	49.66	39.82	72.83	99.83	99.99
38GHz	54.00	18.33	77.16	102.83	102.16
39GHz	43.82	39.16	67.82	100.99	100.82
40GHz	47.35	11.36	60.85	92.69	92.52

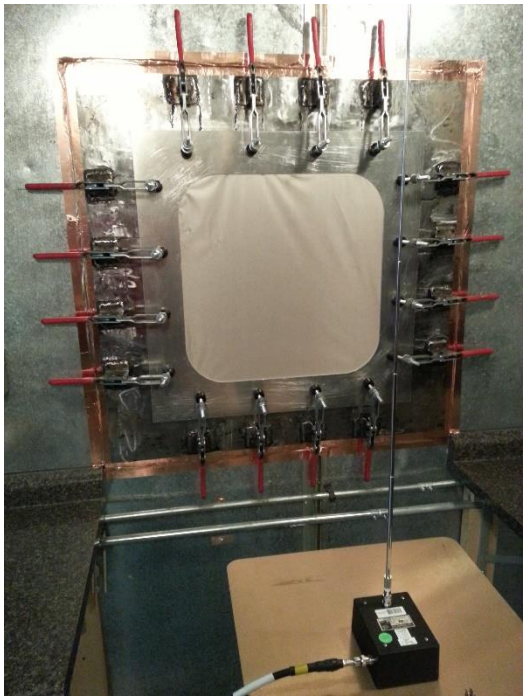
3.1.4 SHIELDING EFFECTIVENESS TEST SETUP PHOTOGRAPHS

Shielding Effectiveness
Small Bag **10kHz to 1GHz**

Shielding Effectiveness
Small Bag **2GHz to 18GHz**

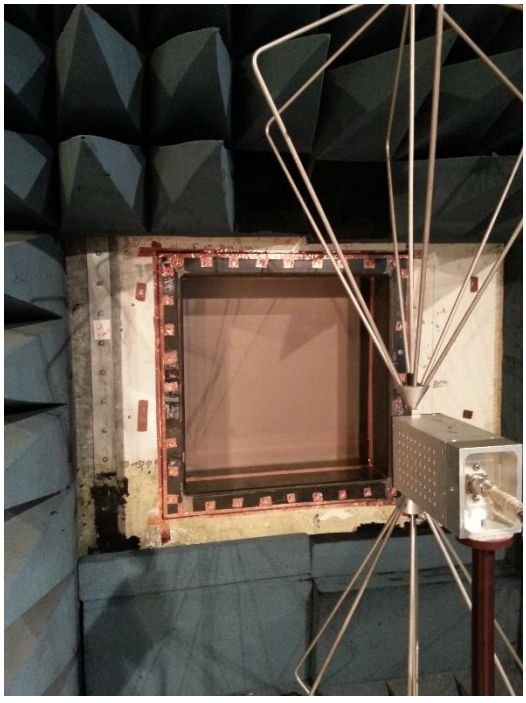
	**Shielding Effectiveness** **Small Bag** **19GHz to 40GHz**

	**Shielding Effectiveness** **Test Setup** **Large Bag**

	**Shielding Effectiveness** **10kHz to 20MHz** **Receive**

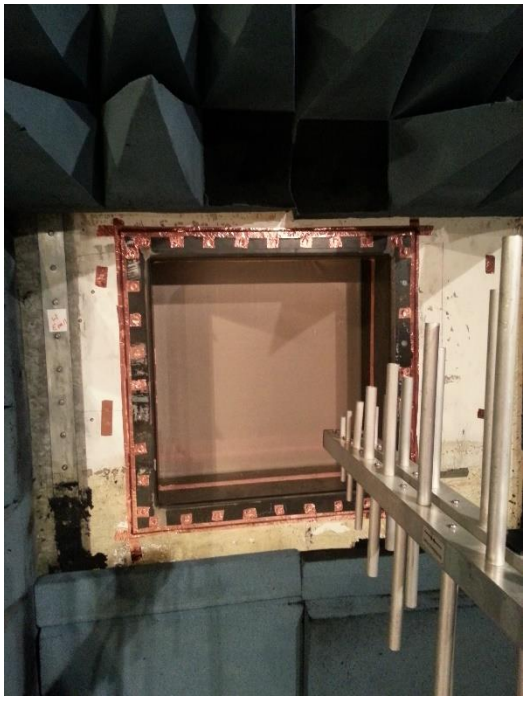
	**Shielding Effectiveness** **10kHz to 20MHz** **Transmit**

Shielding Effectiveness
30MHz to 200MHz Receive



Shielding Effectiveness
30MHz to 200MHz Transmit

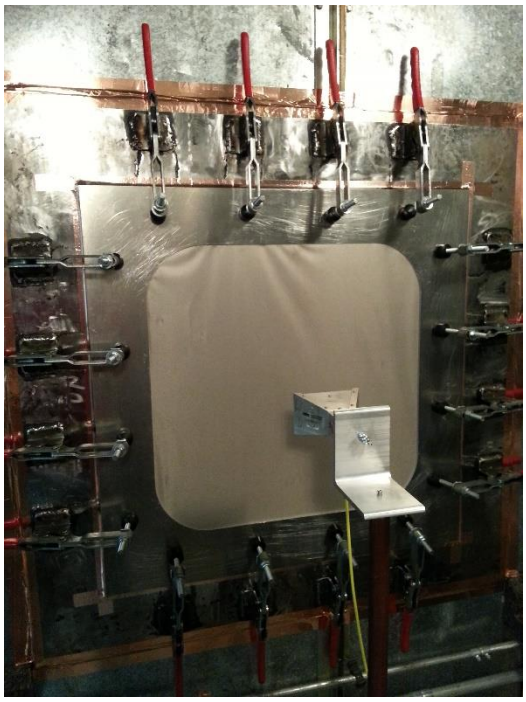
Shielding Effectiveness
300MHz to 1GHz Receive



Shielding Effectiveness
300MHz to 1GHz Transmit

	**Shielding Effectiveness** **2GHz to 18GHz** **Receive**

	**Shielding Effectiveness** **2GHz to 18GHz** **Transmit**

	**Shielding Effectiveness** **19GHz to 40GHz** **Receive**

	**Shielding Effectiveness** **19GHz to 40GHz** **Transmit**

SECTION 4 – CONCLUSION

a) The Fabric Samples & Faraday Bags (Qty 5), Model Number: N/A; Part Number: N/A; Serial Number: N/A, were subjected to the following EMC Tests in accordance with MIL-STD-188-125-2 and the specifications as shown in Table 2:

TABLE 2 TESTS PERFORMED & RESULTS

Test Description	Specification	Results
MIL-STD-188-125-2		
Shielding Effectiveness	**MIL-STD-188-125-2**	**Compliant**

b) The Fabric Samples & Faraday Bags (Qty 5) were returned to MOS Equipment after completion of the Shielding Effectiveness Test.