Shielding Effectiveness Test Report

Tests Performed On

An RFI Cabinet

Model No. CRFFX-70-19-30

In Accordance With MIL-STD-285

Issue Date : September 9, 1991

Manufacturer : AMCO Engineering Co.
3801 N. Rose St.
Schiller Park, Illinois 60176-3152

Prepared By : Radiometrics Midwest Corporation
2200 S. Main Street
Lombard, Illinois 60148

Report Written By: Joseph Strzelecki

Joseph Strzelecki
EMI Test Engineer
NARTE EMC-000877-NE

Report Approved By : Dennis P. Rollinger

Dennis P. Rollinger
Chief Executive Officer

Radiometrics Project : 1979

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Administrative Data

Test Item ID: Model No. CRFFX72-19-30
With "Ultra-Soft" Beryllium Gaskets

Manufacturer: AMCO Engineering Co.
3801 N. Rose St.
Schiller Park, Illinois 60176-3152

Test Specifications: MIL-STD-285 "Attenuation Measurements for Enclosures, Electromagnetic Shielding, for Electronic Test Purposes, Method of"

Tested By: Joseph Strzelecki
EMI Engineer

William J. Bryla
EMC Technician

Witnessed By: Chuck Broad
AMCO Engineering

Test Date: August 19, 1991

Radiometrics Project: 1979

RF Shielding Effectiveness Test Report

1.0 INTRODUCTION

On August 19, 1991, electromagnetic shielding effectiveness tests were performed on an electronic equipment cabinet. The cabinet is identified as an AMCO No. CRFFX72-19-30, and shall hereinafter be referred to as the test item. The test item was manufactured by AMCO. The tests were performed in accordance with the procedures defined in MIL-STD-285.

2.0 TEST ITEM DESCRIPTION

The test item was an electronic equipment enclosure. The overall dimensions of the test item are 72" H X 19" W X 30" D. The test item is designed to house standard 19" rack mount devices. The test item has Ultra-Soft Beryllium Gaskets Part Number 98-515-02 on the doors and base panel. Monel mesh Dou-strip #H454 gasket was used on the side panels. The main channels were sealed with metal plugs.

3.0 TEST SPECIFICATION

The tests were performed to determine the overall RF shielding effectiveness characteristics of the test item. The test procedures were in accordance with MIL-STD-285.

4.0 TEST DESCRIPTION

Tests were performed at Radiometrics Midwest Corporation's Open Field Test Facility, located on Helmar Road near Newark, Illinois. The tests measured electric fields from 100 kHz to 30 MHz and plane wave fields from 30 to 1000 MHz.

The tests were performed at discrete frequencies, at intervals of 3 per frequency octave. The measurements were performed using vertical polarization.

5.0 TEST ITEM SETUP AND OPERATION

Drawings of the test setup is provided on Figures 1 and 2. Photographs are provided on Figures 3 and 4.

6.0 TEST EQUIPMENT

A complete list of appropriate test equipment is provided on Table I. The test equipment calibration is maintained through an approved MIL-STD-45662 calibration program, with traceability to the National Institute of Standards and Technology. The most recent calibration dates for the test equipment are included on the equipment list herein.

7.0 TEST PROCEDURES

7.1 Electric Field Measurements (0.1 to 30 MHz)

Reference Measurements Were Performed As Follows:

The transmitting and receiving antennas were positioned in the center of the 20 foot turntable at the test site. The signal generator was set to produce a CW signal at 100 kHz and input into a 100 Watt amplifier. In order to protect the receive antenna, a 30 dB attenuator was connected between the amp and antenna. The signal generator output was adjusted to maximum and was fed to a vertically polarized electric field antenna.

The amplitude of the transmitted signal was measured at a distance of 1.0 meters with a vertically polarized active rod antenna. The height of this antenna was adjusted to match the height of the transmitting antenna. The output of the receive antenna was fed to a spectrum analyzer via a 25 foot length of RG-55 coaxial cable. The amplitude was measured and recorded.

Test Measurements Were Performed As Follows:

The transmitting antenna was positioned in the center of the 20 foot turntable at the test site. The transmitting equipment settings and cabling that were used for the reference measurements were exactly repeated except that the 30 dB attenuator was removed. The receive antenna and the spectrum analyzer were placed inside the cabinet. The test item was not moved for the electric field tests. The peak amplitude indication on the spectrum analyzer was recorded. The distance between the antennas was 1.0 meters.

The above procedures were repeated over the range from 100 kHz to 30 MHz, at frequency intervals of 3 per frequency octave. Reference measurements were performed at the same frequencies as leakage measurements.

The above tests were performed with the antennas facing the side of the cabinet and a door of the cabinet.

The shielding effectiveness was calculated by subtracting the leakage signal levels (in decibels) from the reference readings (in decibels) at each frequency. In order to account for the attenuator, 30 dB was added to each reference reading.

7.2 Plane Wave Measurements (30 to 1000 MHz)

Reference Measurements Were Performed As Follows:

The transmitting equipment was positioned in the center of the large turntable at the test site. The signal generator was set to produce a CW signal at 30 MHz. The signal generator output was amplified to 1 Watt (nominal) and was fed to a vertically polarized dipole antenna: The antenna height was adjusted to 50 inches above the ground.

The amplitude of the transmitted signal was measured at a distance of 3.0 meters with a vertically polarized biconical antenna. The height of the biconical antenna was adjusted to match the height of the dipole antenna. The output of the biconical antenna was fed to a spectrum analyzer via an 8 foot length of RG-58/U coaxial cable. The test equipment was powered by a storage battery and an inverter. The amplitude of the received signal was measured and recorded.

The dipole was tuned at 145 MHz for the test frequency range from 30 to 190 MHz, and at 400 for the frequency range from 200 to 1000 MHz.

Test measurements were performed as follows:

The spectrum analyzer was placed inside of the test item which was positioned in the center of the test site. The spectrum analyzer was again powered by a storage battery and an inverter. The transmitting equipment settings that were used for the reference measurements were exactly repeated. At each frequency, the spectrum analyzer was placed in the "Max Hold" mode and the test item was slowly rotated about its vertical center axis. The peak amplitude indication on the spectrum analyzer was recorded. The 3.0 meter test distance was measured from the center of the test item to the receive antenna. Measurements were performed at frequency intervals of three per octave. Reference measurements were performed at the same frequencies as leakage measurements.

8.0 SAMPLE CALCULATIONS

The shielding effectiveness of the test item is determined by calculating the difference between the reference meter reading and the test sample meter reading. For example, at 60 MHz, the reference reading, which was taken with no obstructions between the antennas, was 117.0 dBuV. The test reading was 28.8 dBuV. The shielding effectiveness (S.E.) was calculated as shown below:

S.E. = Reference Mtr. Rdg. - Test Sample Mtr. Rdg.
S.E. = 117.0 - 28.8
S.E. = 88.2 dB

The cable losses, antenna factors, etc., were eliminated from the calculations by using the same antennas, cables, and other equipment for both the reference and test readings.

Electric field shielding effectiveness of the test item is determined slightly differently. 30.0 dB was added to the reference reading because of the attenuator not used during leakage measurements. For example, at 10 MHz, the reference reading with the attenuator, which was taken with no obstructions between the antennas, was 94.7 dBuV. The test reading was 30.7 dBuV (without the attenuator). The shielding effectiveness (S.E.) was calculated as shown below:

S.E. = Ref. Mtr. Rdg. + Atten. - Test Sample Mtr. Rdg.
S.E. = 94.7 + 30.0 - 30.7
S.E. = 94.0 dB

9.0 TEST RESULTS

The results are also presented in tabular format on Data Pages 101 and 102.

10.0 CONCLUSIONS

The test item had a maximum of 97.8 dB of shielding and a minimum of 45.8 dB plane wave shielding effectiveness from 30 to 1000 MHz. The test item had a maximum of 100.7 dB of shielding and a minimum of 77.0 dB electric field shielding effectiveness from 0.1 to 30 MHz.

11.0 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was obtained using calibrated instruments and valid measurement procedures.

Table I

EQUIPMENT LIST

Manufacturer/ Description	Model No.	Serial No.	Calibration Date	Designation
Anritsu Spectrum Analyzer	MS2601A	MT49367	5/91	REC-1
Emco 41" Rod Antenna	3301	2314	6/91	ANT-1
Tensor Biconical Antenna	4104	2231	10/90	ANT-2
EMCO Log-Periodic Ant.	3146	1248	10/90	ANT-3
Radiometrics Dipole Antennas	HW1010	201	10/90	ANT-4
IFI E-Field Generator	EFG-3	----	N/A	ANT-5
Fluke RF Synthesizer	6060A	3705024	8/91	SIG-1
RF Labs RF Amplifier	250-145	64884	N/A	AMP-1
Radiometrics RF Amplifier	1W1000	PA101	N/A	AMP-2
Hewlett Packard Preamplifier (extended to 1 GHz)	8447A	2123A06702	3/91	AMP-3
Tripp Lite DC to AC Inverter	PV-400	----	N/A	PWR-1

N/A - Not applicable; Not used as a calibrated device.

Note: Active devices such as analyzers or signal generators are calibrated at least once every six months. Passive devices such as antennas or attenuators are calibrated at least once a year.

Note: The antenna inside the cabinet was vertically polarized and placed in the center of the cabinet.

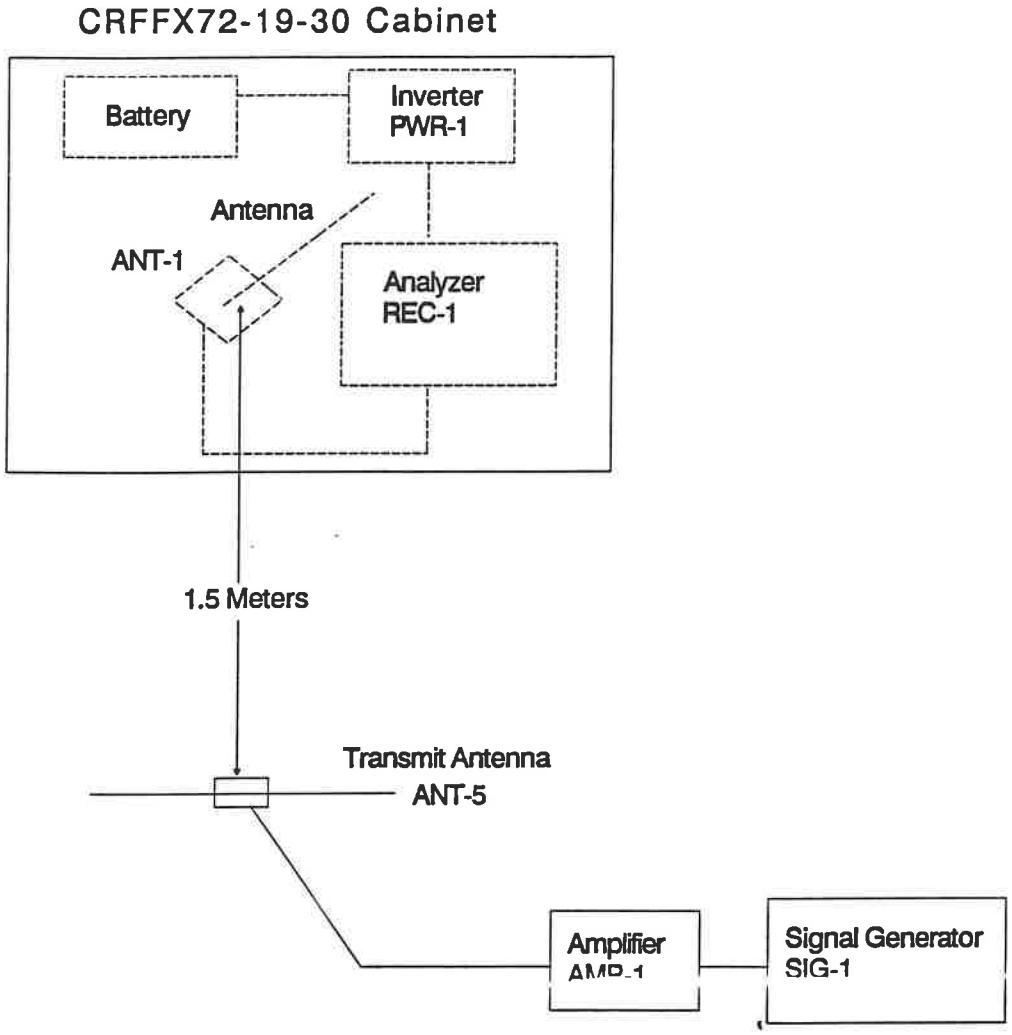

Figure 1

Configuration of Test Setup Electric Field (0.1 - 30 MHz)

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Note: The antenna inside the cabinet was vertically polarized and placed in the center of the cabinet. For each test frequency the cabinet was rotated 360 degrees.

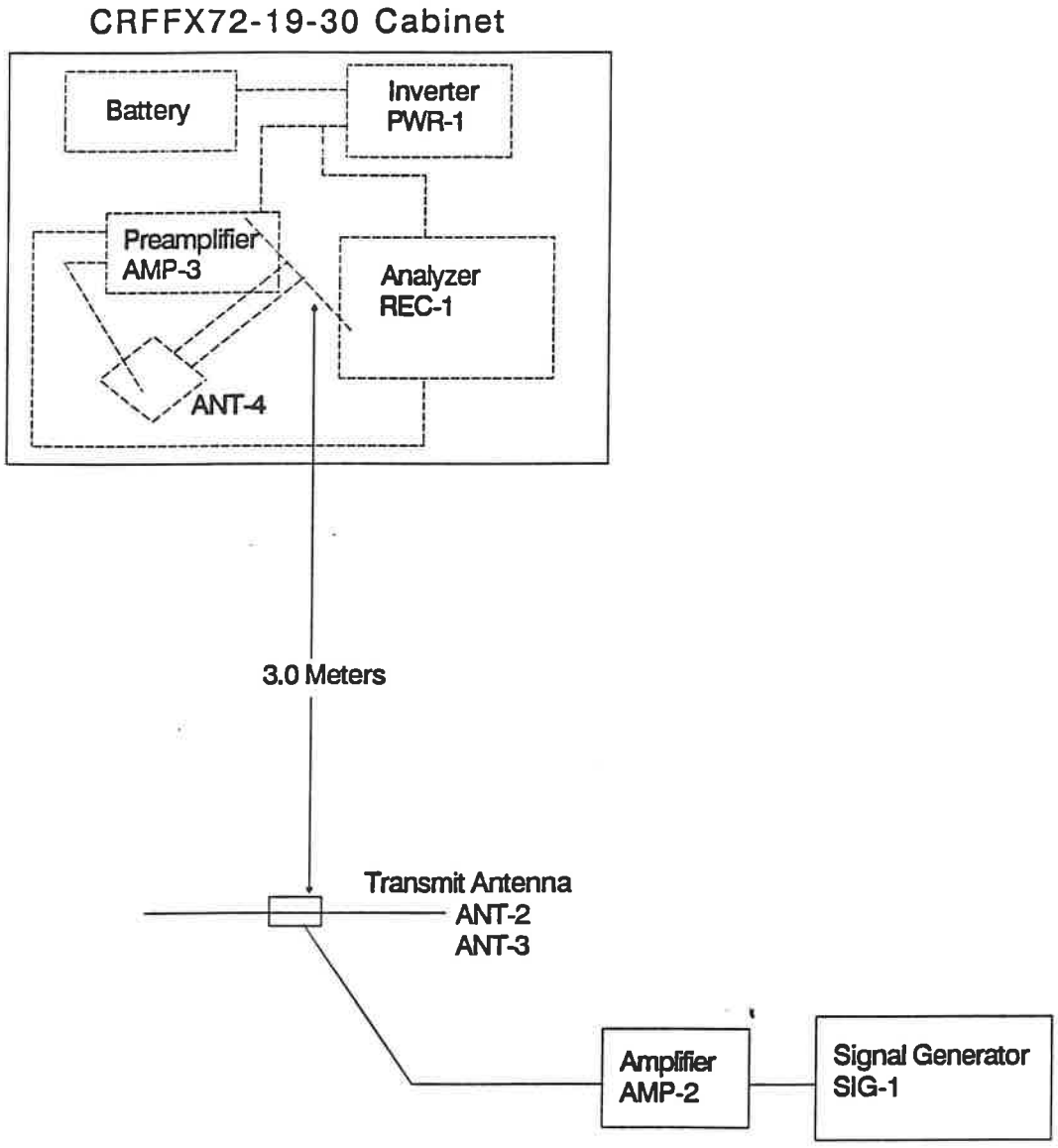

Figure 2

Configuration of Radiated Test Setup Plane Waves (30 - 1000 MHz)

RP-1979

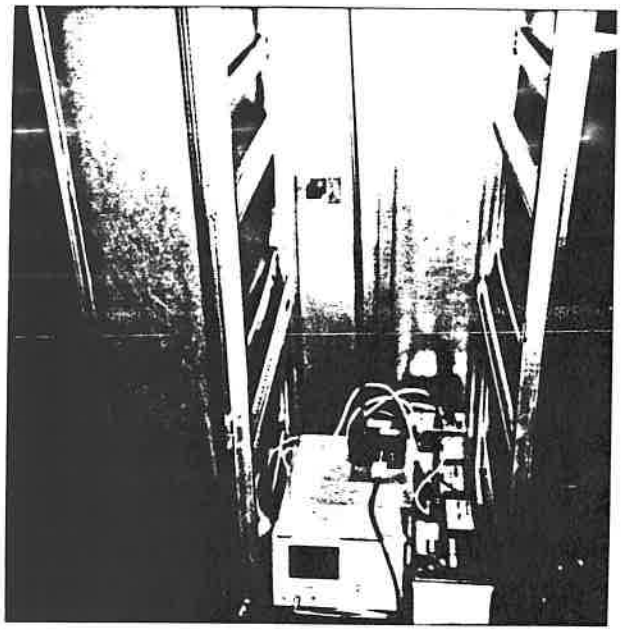

Figure 3
Photographs of Test Setup

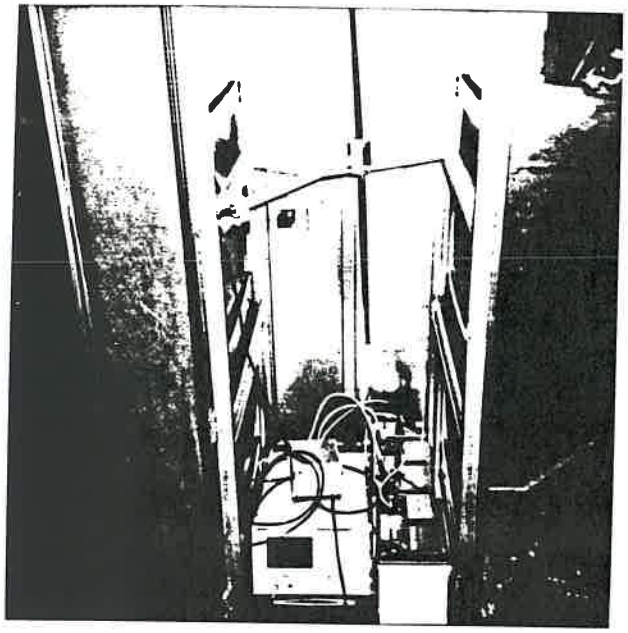

Figure 4
Photograph of Test Setup

Manufacturer : Amco Engineering Company
Test Item : CRFFX72-19-30
Test Description : RF Shielding Effectiveness
Test Specification : MIL-STD-285
Test Date : August 19, 1991

Electric Field Measurements (100 kHz to 30 MHz)

Frequency MHz	Reference Mtr. Rdg. dB(uV)	Antennas Facing Door Mtr. Rdg. dB(uV)	Facing Side of Cabinet Mtr. Rdg. dB(uV)	Front Door Shielding Effect. dB	Side of Cabinet Shielding Effect. dB
0.100	116.6	25.0	5.0*	91.6	>111.6
0.126	116.8	30.0	5.0*	86.8	>111.8
0.159	117.4	27.5	5.0*	89.9	>112.4
0.200	118.0	28.0	5.0*	90.0	>113.0
0.252	118.6	26.9	5.0*	91.7	>113.6
0.317	120.2	26.3	5.0*	93.9	>115.2
0.400	122.8	27.9	5.0*	94.9	>117.8
0.504	122.2	28.5	5.0*	93.7	>117.2
0.635	116.1	28.4	5.0*	87.7	>111.1
0.800	115.0	29.1	5.0*	85.9	>110.0
1.00	114.6	29.9	5.0*	84.7	>109.6
1.26	113.6	29.5	10.3	84.1	103.3
1.59	114.1	30.9	19.0	83.2	95.1
2.00	114.1	31.1	18.5	83.0	95.6
2.52	117.9	31.4	18.6	86.5	99.3
3.17	121.5	32.6	15.5	88.9	106.0
4.00	117.4	32.7	17.5	84.7	99.9
5.04	116.9	31.1	9.0	85.8	107.9
6.35	121.8	31.8	18.9	90.0	102.9
8.00	127.3	31.5	29.3	95.8	98.0
10.0	124.7	30.7	30.6	94.0	94.1
12.6	131.3	30.6	25.1	100.7	106.2
15.9	120.1	30.3	34.0	89.8	86.1
20.0	117.8	29.6	31.4	88.2	86.4
25.2	118.5	33.7	38.0	84.8	80.5
30.0	124.0	42.2	47.0	81.8	77.0

*-ambient

Checked By Joseph Stybel

Manufacturer : Amco Engineering Company
Test Item : CRFFX72-19-30
Test Description : RF Shielding Effectiveness
Test Specification : MIL-STD-285
Test Date : August 19, 1991

Plane Wave Measurements (30 to 1000 MHz)

Frequency MHz	Reference Meter Reading dB(uV)	Antennas Facing Test Sample Meter Reading dB(uV)	Side of Cabinet Shielding Effect. dB
30.0	91.6	7.2	84.4
37.8	100.0	24.4	75.6
47.6	108.8	21.1	87.7
60.0	117.0	28.8	88.2
75.6	125.7	27.9	97.8
95.2	123.1	30.3	92.8
120.0	129.7	36.5	93.2
151.2	121.7	45.1	76.6
190.5	124.7	44.7	80.0
240.0	114.6	50.8	63.8
302.0	124.1	68.3	55.8
381.0	129.1	75.4	53.7
480.0	109.2	51.6	57.6
605.0	104.2	47.1	57.1
762.0	113.6	67.8	45.8
960.0	104.1	56.4	47.7
1000.0	107.3	61.4	45.9

Checked By Joseph Stybel

Enhanced CRFFX Vs. Std. CRFFX