Serial No. GM24075f
FCC ID: IB2AISD1

# FCC TEST REPORT
# FOR THE
# L3 COMMUNICATIONS
# AVIATION RECORDERS CORPORATION
# AUTOMATIC IDENTIFICATION SYSTEM

**Prepared for:**

L3 Communications Aviation Recorders Corp.
6000 Fruitville Road
Sarasota, FL 34232
USA

**Submitted by:**


**Green Mountain Electromagnetics, Inc.**

**(802) 388-3390**
**Fax: (802) 388-6279**
**E-mail: gme@gmelectro.com**
**219 Blake Roy Road • Middlebury, Vermont 05753**




**Accredited**
Cert 898.01

# L3 Communications Aviation Recorders Corporation
# FCC Tests
# By
# Green Mountain Electromagnetics, Inc.
# Middlebury, Vermont

**Unit: Automatic Identification System (AIS)**
**Evaluated: November 8 through 12, 2004**

## I. Applicable Standards:

The unit described in this report was measured for certification with the Code of Federal Regulations Chapter 47 – "Telecommunication, Part 2 – Frequency Allocations and Radio Treaty Matters: General Rules and Regulations, Subpart J – Equipment Authorization Procedures (2002)." Measurements required were per paragraphs 2.1046 RF Power Output, 2.1047 Modulation Characteristics, 2.1049 Occupied Bandwidth, 2.1051 Spurious Emissions at Antenna Terminals, 2.1053 Field Strength of Spurious Radiation, 2.1055 Frequency Stability, and 2.1091 Radiofrequency Radiation Exposure Evaluation: Mobile Devices.

The AIS was also measured for verification of compliance with "CFR47 – Telecommunication, Part 80 – Stations in the Maritime Services, Subpart E: General Technical Standards (2002)." Paragraphs used were 80.205 Bandwidths, 80.209 Transmitter Frequency Tolerances, 80.211 Emission Limitations, 80.213 Modulation Requirements, 80.215 Transmitter Power, and 80.217 Suppression of Interference Aboard Ships. Additionally, the AIS was measured for verification of compliance with "CFR47, Part 15 – Radio Frequency Devices, Subpart B: Unintentional Radiators, Paragraph 15.109, Radiated Emissions Limits (2002)."

Measurement procedures were in accordance with ANSI C63.4, "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2000)," IEC 61993-2, "Maritime Navigation and Radiocommunication Equipment and Systems – Automatic Identification Systems (AIS), Part 2: Class A Shipborne Equipment of the Universal AIS – Operational and Performance Requirements, Methods of Test and Required Test Results (December 2001)," and FCC OET Bulletin 65, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields (August 1997)."

## II. Unit Tested:

The L3 Communications Aviation Recorders Corporation, Automatic Identification System provides continuous signal and data transmission for ship identification. The AIS uses 24-VDC power, has TDMA/DSC transmitters and TDMA/GPS/DSC receivers. It consists of the two-piece metal enclosure with connector hardware, the transmit/receive circuits, the micro-processor/data-storage electronics, and the antenna interface. The table below describes the unit tested to determine compliance with the standards:

| Model/P/N | Manufacturer | H/W/D in cm | Serial Number |
|---|---|---|---|
| AISD1-000-00 | L3 Communications | 8/15/20 | 104 |

The highest frequency investigated is ten times the AIS highest fundamental (1.63 GHz). IEC 61993-2, Paragraph 13 masks are used to demonstrate modulation characteristics.

## III. Measurement Location:

The GME laboratory and Open Area Test Site (OATS) are located at 219 Blake Roy Road, Middlebury, VT. The OATS is a 3-meter site complete with antenna positioner, ground plane and motorized turntable. The OATS is constructed in accordance with ANSI C63.7-1992 and complies with the requirements for radiated emissions testing in ANSI C63.4-2000 and CISPR 16-1993. The electromagnetic laboratory is constructed in accordance with CE immunity standards and ANSI C63.4-2000 (conducted emissions).

GME is internationally accredited by the American Association for Laboratory Accreditation (A2LA) and meets the quality requirements in ISO/IEC 17025 (1999), "General Requirements for the Competence of Testing and Calibration Laboratories."

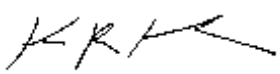
## IV. Summary of Results:

The L3 Communications Aviation Recorders Corporation, AIS complies with the requirements in CFR 47, Paragraphs 2, 15 and 80. Section IX contains the results summarized in the table below.

| | Test | Mode/Port | CFR 47 Paragraph | Frequency Range/Level | Specified Values | Measured Values |
|---|---|---|---|---|---|---|
| **1** | Carrier Power | Transmit | **2.1046**<br>**80.215** | ±1.5 dB<br>1W - 25 W | 40.96 dBm<br>33.01 dBm | 40.49 dBm<br>32.48 dBm |
| **2** | Modulation Characteristics | Transmit | **2.1047**<br>**80.213** | 25 kHz lmt.<br>12.5 kHz lt. | 61993-2 Fig. 4<br>61993-2 Fig. 5 | Within Limit<br>Within Limit |
| **3** | Occupied Bandwidth | Transmit | **2.1049**<br>**80.205** | Fundamental | 0.5 % | Within Limit |
| **4** | Conducted Spurious | Receive/ Transmit | **2.1051**<br>**80.217** | Below 30 MHz<br>30 - 100 MHz<br>100 - 300 MHz<br>300 MHz to 1.63 GHz | -4 dBm<br>6 dBm<br>16 dBm<br>26 dBm | <-30 dBm<br><-30 dBm<br><5 dBm<br><-30 dBm |
| **5** | Frequency Tolerance | Transmit | **2.1055**<br>**80.209** | ± 10 ppm<br>90% - 130% V | 156,025,000 Hz<br>157,412,500 Hz<br>160,637,500 Hz<br>162,025,000 Hz<br>21.6 V - 31.2 V | 156,024,795 Hz<br>157,412,291 Hz<br>160,637,266 Hz<br>162,024,751 Hz<br>21.6 V - 31.2 V |
| **6** | Radiated Emissions | Enclosure | **15.109**<br>**2.1053**<br>**80.211** | 30 - 88 MHz<br>88 - 216 MHz<br>216 - 960 MHz<br>960 - 1630 MHz | 40 dBuV/m<br>43.5 dBuV/m<br>46 dBuV/m<br>54 dBuV/m | Within<br>All Limits |
| **7** | Exposure Evaluation | Enclosure | **2.1091** | 0.3 - 3 MHz<br>3 - 30 MHz<br>30 - 300 MHz<br>300 - 1630 MHz | 100 $mW/cm^2$<br>$900/f^2$ $mW/cm^2$<br>1 $mW/cm^2$<br>$f/300$ $mW/cm^2$ | Within<br>All Limits |

Testing was performed by Kyle R. Kowalczyk, president, Green Mountain Electromagnetics and requested by:

L3 Communications Aviation Recorders Corp.
6000 Fruitville Road
Sarasota, FL 34232
USA



Kyle R. Kowalczyk
11/22/04

## V. Measuring Equipment:

The table below describes the instrumentation used by Green Mountain Electromagnetics to perform this testing:

| Unit | Manufacturer | Model | Serial # | Last Cal. | Next Cal. |
|---|---|---|---|---|---|
| Spectrum Analyzer | Hewlett-Packard | 8592 | 3624A00631 | 1/13/04 | 1/13/05 |
| Preamplifier | Hewlett-Packard | 8447 D | 2944A07313 | 5/17/04 | 5/17/05 |
| Signal Generator | Hewlett-Packard | E4421B | US38220195 | 10/20/04 | 10/20/05 |
| Plotter | Hewlett-Packard | 7475A | 2517A05281 | n/a | n/a |
| PC/Monitor | L3 Configured | 9591 | MIS9591 | n/a | n/a |
| Broadband E-field Antenna | Antenna Research Associates | LPB-2513/A | 1125 | 10/20/04 | 10/20/05 |
| Frequency Counter | Agilent | 53181A | ID5111 | 4/27/04 | 4/27/05 |
| Power Sensor | Agilent | E9301B | ID5119AB | 6/7/04 | 6/7/05 |
| Power Meter | Agilent | E4418B | ID5113 | 4/27/04 | 4/27/05 |
| Power Supply | Hewlett-Packard | 6083 | 500771 | 12/10/04 | 12/10/05 |

## VI. Equipment and Cable Configuration:

GME witnessed the unit in satisfactory condition for testing, however the manufacturer is responsible for ensuring that the equipment under test (EUT) represents the product line. The manufacturer is also responsible for the EMC test plan and for assuring that this report is consistent with that plan. The EUT configuration was arranged to produce maximum radiated emissions as shown in the block diagram below, as well as in the photographs in Section VIII. The equipment was subjected to complete emissions tests.

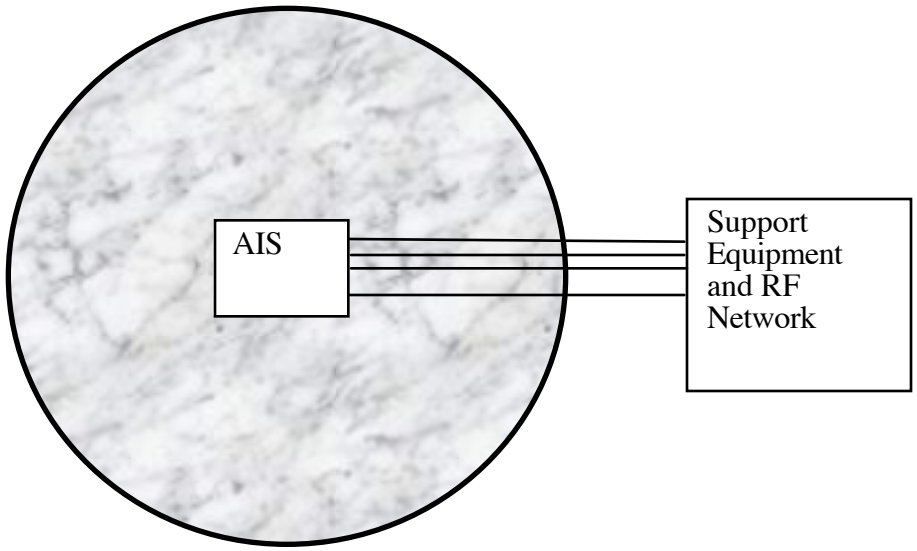



Figure 1 – Block Diagram of EUT on Turntable

The EUT was operating in a continuous mode utilizing and testing its RF signal processing functions. Data with known properties were downloaded from the PC to the AIS, uploaded from the AIS to the PC, and evaluated for errors during testing. The AIS was also set to self-test upon power up.

## VII. Measurement Procedures for AIS FCC Tests:

### 1. Carrier Power.

High Specification: 40.96 ± 1.5 dBm (12.5W +5.1W/-3.1W) Normal Operation

Low Specification: 33.01 ± 1.5 dBm (2W +.8W/-.6W) Normal Operation

a. Set up EUT and test instrumentation in laboratory.
   i. Connect AIS to 24-VDC power and GPS antenna; attach 30-dB attenuator to VHF port.

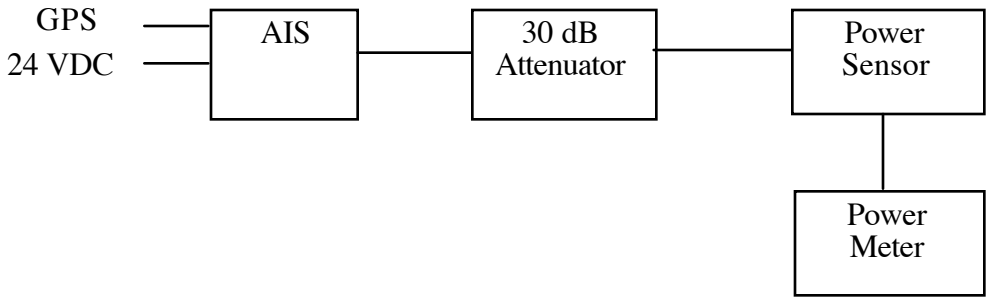
b. Verify power meter/sensor and AIS operation.
   i. Power sensor is connected to 30-dB attenuator.
   ii. AIS power levels are selected from front panel.
   iii. Power meter requires zeroing and calibration each time.

c. Verify AIS frequency with non-contact probe and spectrum analyzer.

d. Operate EUT at high power unmodulated.

e. Record level displayed on meter.

f. Repeat for low power.




Block Diagram of Carrier Power Test

## VII. Measurement Procedures for AIS FCC Tests Cont'd:

**2. Modulation Characteristics.**

25kHz Envelope: 0dB ±10kHz, decrease -25dBc to -70dBc from ±10kHz to ±25kHz

12.5kHz Envelope: 0dB ±2.5kHz, decrease 0dBc to -60dBc from ±2.5kHz to ±12.5kHz

a. Set up EUT and test instrumentation in laboratory.
   i. Connect AIS to 24-VDC power and GPS antenna; attach 30-dB attenuator to VHF port.

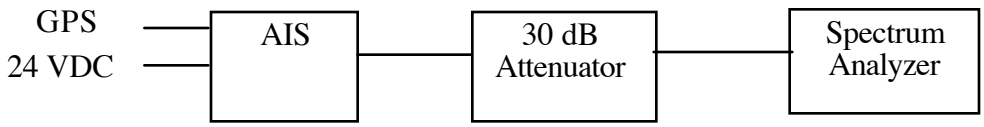
b. Verify analyzer and AIS operation.
   i. Spectrum analyzer is connected to 30-dB attenuator.
   ii. AIS test signals 1, 2 & 3 per 61993-2, Para. 10.4 are selected from front panel.
   iii. Spectrum analyzer requires warm-up period.

c. Verify AIS test signal on spectrum analyzer.

d. Operate EUT at first selected test signal with standard modulation.

e. Record frequency spectrum displayed on analyzer.

f. Repeat for each TDMA and DSC test signal.




Block Diagram of Modulation Spectrum Test

## VII. Measurement Procedures for AIS FCC Tests Cont'd:

### 3. Occupied Bandwidth.

Specification: 0.5% carrier power

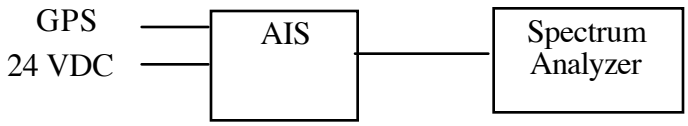
a. Set up EUT and test instrumentation in laboratory.
   i. Connect AIS to 24-VDC power and GPS antenna.

b. Verify analyzer and AIS operation.
   i. Spectrum analyzer is connected to VHF port.
   ii. AIS test signals 1, 2 & 3 are selected from front panel.
   iii. Spectrum analyzer requires warm-up period.

c. Verify AIS test signal on spectrum analyzer.

d. Operate EUT at first selected test signal with standard modulation.

e. Record fundamental frequency displayed on analyzer.
   i. Repeat for each TDMA and DSC test signal.



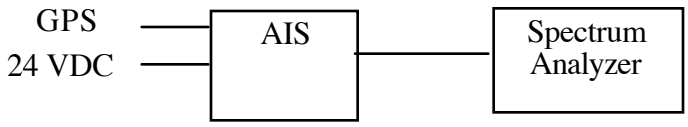

Block Diagram of Occupied Bandwidth Test

## VII. Measurement Procedures for AIS FCC Tests Cont'd:

### 4. Conducted Spurious.

Specification: Below 30 MHz: -4 dBm
30 MHz to 100 MHz: 6 dBm
100 MHz to 300 MHz: 16 dBm
300 MHz to 1.63 GHz: 26 dBm

a. Set up EUT and test instrumentation in laboratory.
   i. Connect AIS to 24-VDC power and GPS antenna.
b. Verify analyzer and AIS operation.
   i. Spectrum analyzer is connected to VHF port.
   ii. AIS test signals 1, 2 & 3 are selected from front panel.
   iii. Spectrum analyzer requires warm-up period.
c. Verify AIS test signal on spectrum analyzer.
d. Operate EUT at first selected test signal with standard modulation.
e. Record frequency spectrum displayed on analyzer.
   i. Repeat for each TDMA and DSC test signal.




Block Diagram of Conducted Spurious Test

## VII. Measurement Procedures for AIS FCC Tests Cont'd:

### 5. Frequency Tolerance.

TDMA Frequencies: 156.025, 157.4125, 160.6375, 162.025 MHz

Specification: ±1.56, 1.57, 1.60, 1.62 kHz Normal Operation

Voltage Specification: 21.6 V to 31.2 V Normal Operation

a. Set up EUT and test instrumentation in laboratory.
   i. Connect AIS to 24-VDC power and GPS antenna; attach 30-dB attenuator to VHF port.

b. Verify frequency counter and AIS operation.
   i. Frequency counter is connected to 30-dB attenuator.
   ii. AIS channels are selected from front panel.
   iii. Frequency counter requires warm-up period.

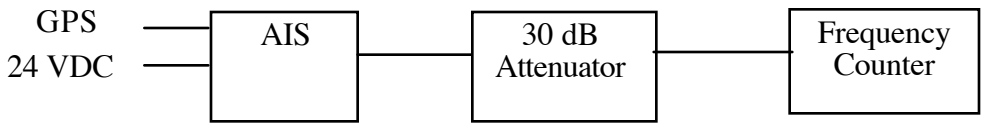
c. Verify AIS frequency with non-contact probe and spectrum analyzer.

d. Operate EUT at first selected channel with no modulation.

e. Record frequency displayed on counter.
   i. Repeat for each TDMA channel – settings are 1060, 1228, 2260 & 2088.

f. Operate EUT at first selected channel with no modulation and at low voltage.

g. Record frequency displayed on counter.
   i. Sweep voltage from low to high and observe any variation in frequency.




Block Diagram of Frequency Test

## VII. Measurement Procedures for AIS FCC Tests Cont'd:

### 6. Radiated Emissions.

Frequency range: 30 MHz to 88 MHz
Limit: 40 dBuV/m @ 3 meters
Frequency range: 88 kHz to 216 MHz
Limit: 43.5 dBuV/m @ 3 meters
Frequency range: 216 MHz to 960 MHz
Limit: 46 dBuV/m @ 3 meters
Frequency range: 960 MHz to 1.63 GHz
Limit: 54 dBuV/m @ 3 meters

a. Set up instrumentation at open area test site.
   i. Mount EUT on turntable and broadband antenna on antenna positioner.
   ii. Record temperature, humidity and atmospheric pressure.
   iii. Measurement distance is 3 meters and antenna scan height is varied from 1 to 4 meters.
b. Verify spectrum analyzer and antenna operation.
   i. Spectrum analyzer is connected to antenna.
   ii. Preamplifier is inserted between antenna and analyzer to ensure analyzer noise threshold is at least 6 dB below specification limit (not normally necessary below 30 MHz).
c. Set up, power and operate EUT as described in Section VI.
d. Perform preliminary evaluation of equipment in the near field.
   i. Vary antenna height, antenna polarization, and antenna orientation to EUT.
   ii. Repeat step d.i. while evaluating electromagnetic radiation in the 30-MHz to 1.63-GHz spectrum.
   iii. Ensure appropriate resolution bandwidth is set and less than or equal to video bandwidth.
   iv. Near field measurements of unit emissions are made at ambient frequencies.
e. Determine frequencies and equipment orientations that produce maximum radiation.
   i. Identify any processor, clock and beat frequencies, and harmonics.
f. Perform final evaluation of unit by recording spectrum analyzer data on the plotter.
   i. Ensure the EUT is producing the maximum radiation found in step e.
   ii. Collect data over the entire frequency range.
   iii. Identify all ambient signals.

## VII. Measurement Procedures for AIS FCC Tests Cont'd:

### 7. Exposure Evaluation.

Frequency range: 0.3 MHz - 3 MHz

Limit: 100 $mW/cm^2$

Frequency range: 3 MHz - 30 MHz

Limit: $900/f^2$ $mW/cm^2$

Frequency range: 30 MHz - 300 MHz

Limit: 1 $mW/cm^2$

Frequency range: 300 MHz - 1630 MHz

Limit: $f/300$ $mW/cm^2$

a. Set up instrumentation at open area test site.
   i. Mount EUT on table and isotropic probe or loop on antenna positioner.
   ii. Record temperature, humidity and atmospheric pressure.
   iii. Measurement distance is 1 meter and antenna scan height is varied over human body dimensions (0.1 to 2 meters).

b. Verify spectrum analyzer and antenna operation.
   i. Spectrum analyzer is connected to antenna.
   ii. Preamplifier is inserted between antenna and analyzer to ensure analyzer noise threshold is at least 6 dB below specification limit (not normally necessary below 30 MHz).

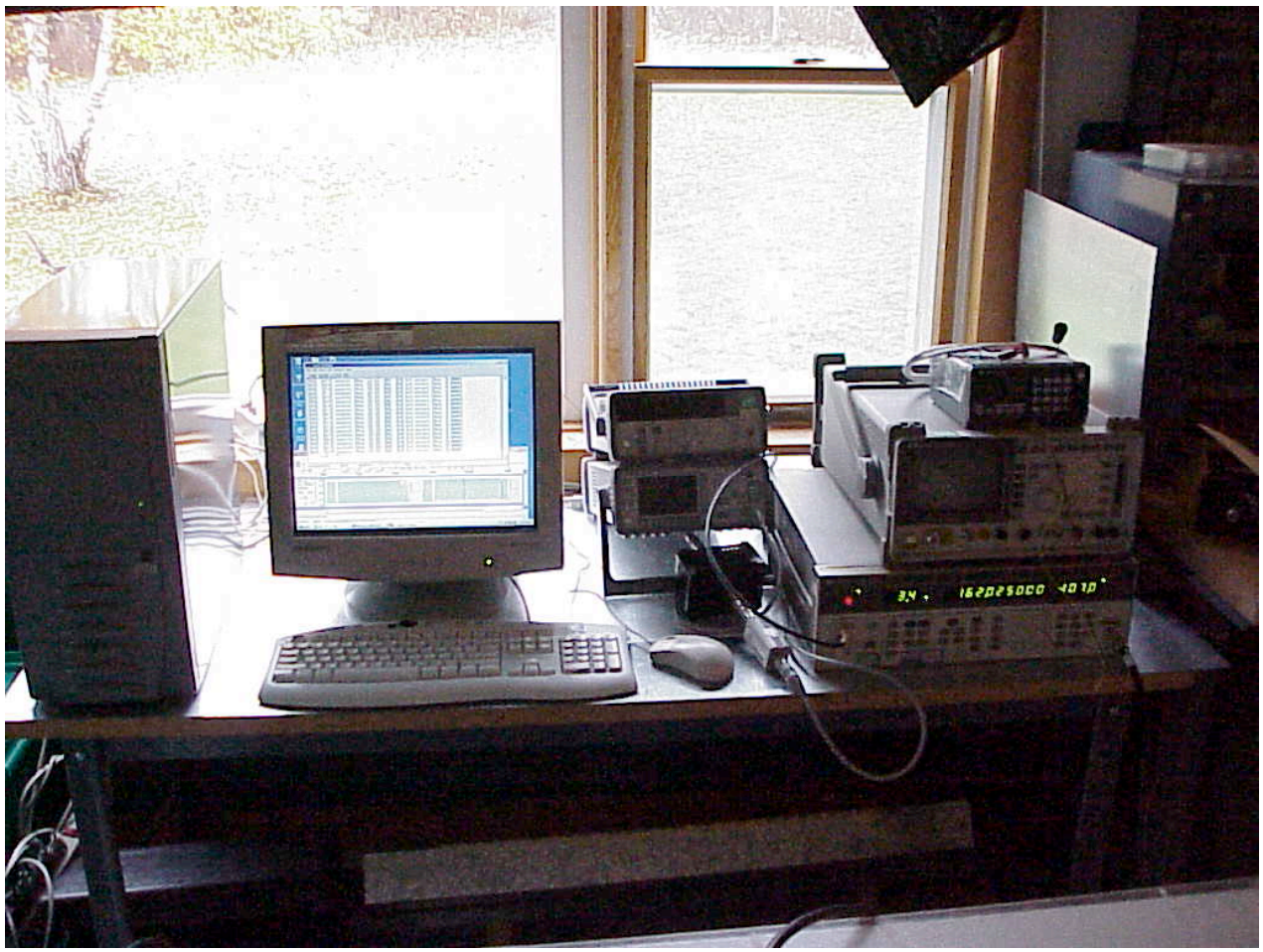
c. Set up, power and operate EUT as described in Section VI.

d. Perform preliminary evaluation of equipment in the near field.
   i. Vary antenna height, antenna polarization, and antenna orientation to EUT.
   ii. Repeat step d.i. while evaluating electromagnetic radiation in the 0.3-MHz to 1630-MHz spectrum. H and E field are both measured below 300 MHz.
   iii. Ensure appropriate resolution bandwidth is set and less than or equal to video bandwidth.
   iv. Near field measurements of unit emissions are made at ambient frequencies.

e. Determine frequencies and equipment orientations that produce maximum radiation.
   i. Set peak hold on analyzer for 6 minutes while slowly varying antenna height.

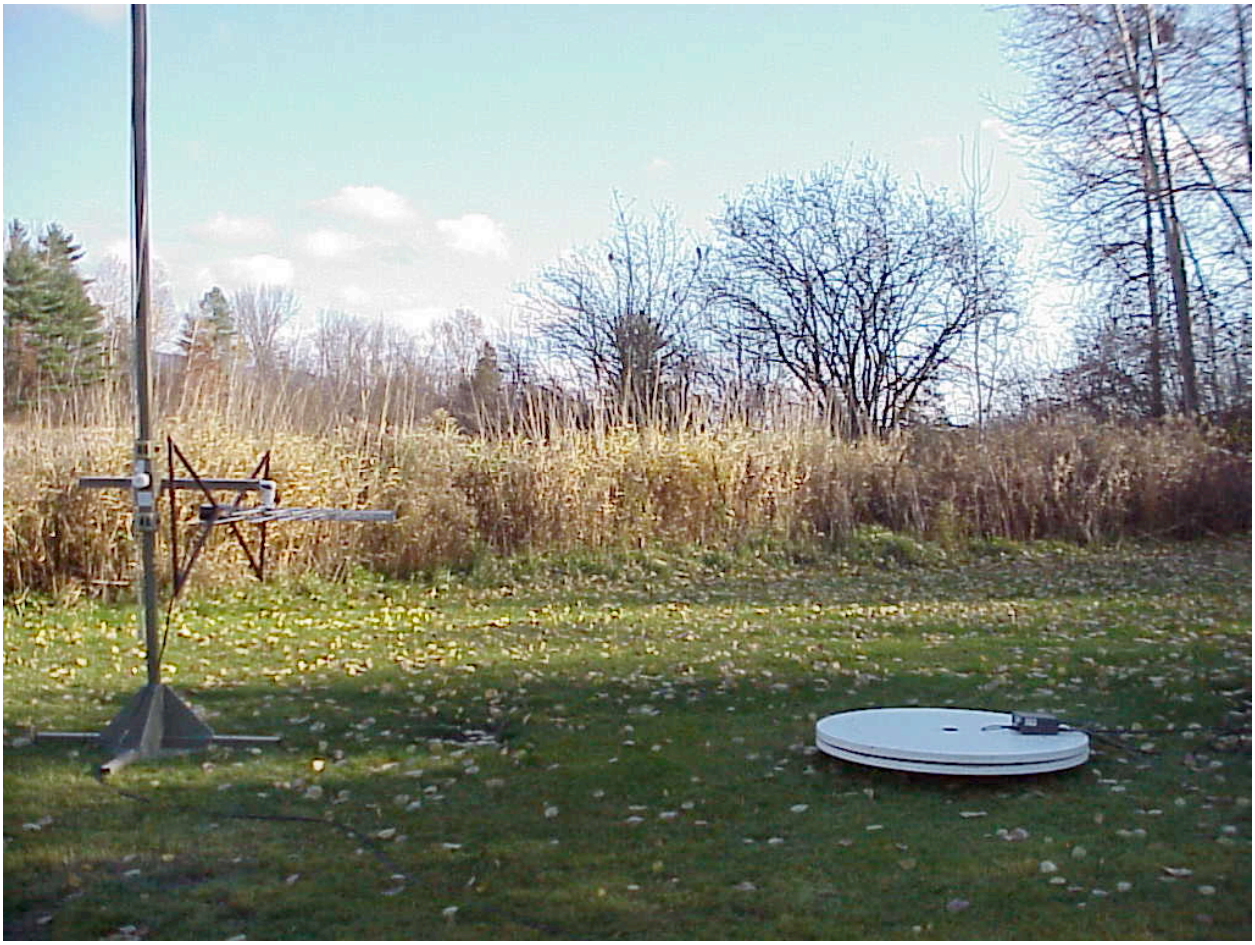
f. Perform final evaluation of unit by recording spectrum analyzer data on the plotter.
   i. Ensure the EUT is producing the maximum radiation found in step e.
   ii. Collect data over the entire frequency range.
   iii. Identify all ambient signals.

## VIII. Test Setup Photographs for AIS FCC Tests:



EUT and Support Equipment

## VIII. Test Setup Photographs for AIS FCC Tests Cont'd:



Radiated Emissions Test Setup