MEASUREMENT/TECHNICAL REPORT

Robertshaw Controls Company - Model: 0625-300
FCC ID: NU9TX0625-0300
February 25, 1998

This report concerns (check one:) Original Grant X Class II Change____

Equipment Type: Transmitter (example: computer, printer, modem, etc.)

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? Yes___ No X

If yes, defer until: _____
date

Company Name agrees to notify the Commission by: _____
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Transition Rules Request per 15.37? Yes___ No X

If no, assumed Part 15, Subpart C for intentional radiator - the new 47 CFR [10-1-91 Edition] provision.

Report prepared by:

David Schramm
Intertek Testing Services
4317-A Park Drive, NW
Norcross, GA 30093
Phone: 770-925-2444
FAX: 770-925-7294

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EXHIBIT 1

GENERAL DESCRIPTION

1.0 General Description

1.1 Product Description

The device is a tank level sensor that uses ultrasonic (≈50 kHz) frequencies to measure liquid levels. The information is stored in a microprocessor and transmitted by means of direct sequence spread spectrum transmitter operating at 923.58 MHz.. The device transmits signals that indicate the status of measurement sensor inputs to a receiver. The device derives its power from an internally mounted 3 Vdc battery.

1.3 Related Submittal(s) Grants

This is a single Application for Certification. There are no simultaneous filings under Part 15.

1.4 Test Methodology

Radiated emission measurements were performed according to the procedures in ANSI C63.4 (1992). All measurements were performed in Open Area Test Sites. Preliminary scans were performed in the Open Area Test Sites only to determine worst case modes. For each scan, the procedure for maximizing emissions in Appendices D and E were followed. All radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this Application.

1.5 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located at 4317-A Park Drive NW, Norcross, Georgia. This test facility has been fully described in a report dated Jan. 8, 1993 submitted to your office. Please reference the site filing number: 31040/SIT 1300F2, dated April 26, 1996. This facility is accredited by the NVLAP program (NVLAP Code: 100409-0).

EXHIBIT 2

SYSTEM TEST CONFIGURATION

2.0 System Test Configuration

2.1 Justification

The system was configured for testing in a typical fashion (as a customer would normally use it). During testing, all cables were manipulated to produce worst case emissions.

For simplicity of testing, the EUT was configured to transmit continuously.

2.2 EUT Exercising Software

There was no special software to exercise the device. For simplicity of testing, the unit was configured to transmit continuously.

2.3 Special Accessories

There are no special accessories for compliance of this product.

Confirmed by:

David J. Schramm
EMI Technical Supervisor
Intertek Testing Services
Agent for Robertshaw Controls Company

David J Schramm
Signature

3/2/98
Date

2.4 Equipment Modifications

Any modifications installed previous to testing by will be incorporated in each production model sold/leased in the United States.

No modifications were installed by Intertek Testing Services, Inc.

Confirmed by:

David J. Schramm
EMI Technical Supervisor
Intertek Testing Services
Agent for Robertshaw Controls Company

David J Schramm
Signature

3/2/98
Date

2.5 Support Equipment List and Description

The FCC ID's for all equipment, plus descriptions of all cables used in the tested system (included inserted cards, which have grants) are:

None

Cables:

None

2.6 Test Configuration Block Diagram

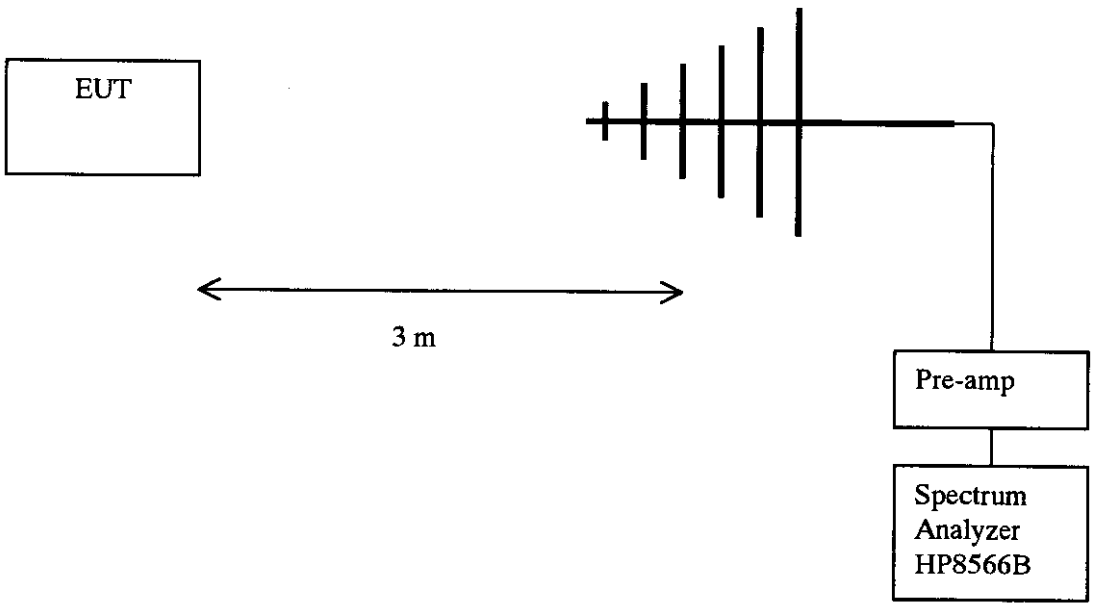

Figure 2.6-1: Configuration of Tested System

EXHIBIT 3

EMISSION RESULTS

3.0 Test Results

Data is included of the worst case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs, data tables and of the emissions are included.

3.1 Emission Bandwidth

§15.247(a)(2) specifies that direct sequence systems shall have a 6 dB bandwidth of at least 500 kHz. From the plot shown on the next page, the emission bandwidth was determined to be 1.435 MHz. For the measurement, the spectrum analyzer resolution bandwidth (RBW) was set to 100 kHz and the frequency span set to 1 MHz.

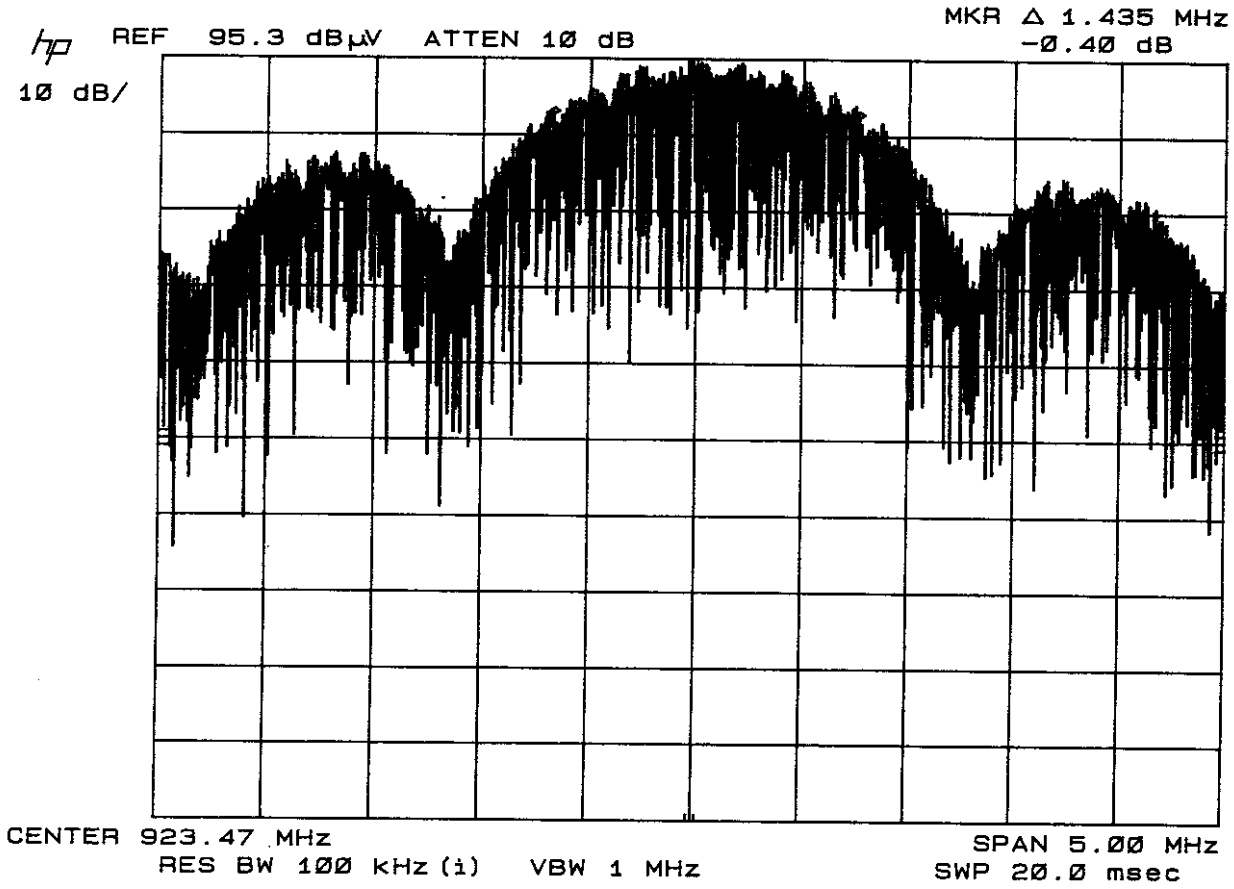

Figure 3.1-1: Emission Bandwidth Plot

3.2 Power Output

§15.247(b)(1) specifies power output requirements for direct sequence spread spectrum transmitters. The maximum peak output power for these devices shall not exceed one watt. If transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by one dB for every three dB that the directional gain of the antenna exceeds 6 dBi.

The peak output power was measured to be 14.3 dBm (26.9 mW). The rated output power of this device is 16 dBm (40 mW). The measured value was within manufacturing tolerances which are approximately 2 dB.

The power was determined by measuring the maximum field strength of the EUT at a distance of 3 meters. This measurement in dB(μV/m) was then converted to dBm using the following equation.

$$E = \frac{\sqrt{30 \cdot P \cdot G}}{d}$$

Where E is the field strength in V/m,
P is the power in Watts
G is the numeric gain of the transmit antenna
d is the distance in meters.

The spectrum analyzer resolution bandwidth (RBW) was set to 1 MHz and video bandwidth (VBW) was set to 3 MHz (this is the maximum VBW setting for the test equipment).

3.3 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
where FS = Field Strength in dB(μV/m)
RA = Receiver Amplitude (including preamplifier) in dB(μV)
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB(1/m)
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows:

Assume a receiver reading of 52.0 dB(μV) is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB(μV/m). This value in dB•V/m was converted to its corresponding level in μV/m.

RA = 52.0 dB(μV)
AF = 7.4 dB
CF = 1.6 dB(1/m)
AG = 29.0 dB

FS = 52.0 + 7.4 + 1.6 - 29.0 = 32 dB(μV/m)

Level in μV/m = Common Antilogarithm [(32 dBμ/V/m)/20] = 39.8 μV/m

3.4 Transmitter Spurious Emissions

§15.247(c) specifies requirements for spurious emissions from direct sequence spread spectrum transmitters. In any 100 kHz bandwidth outside the frequency bands listed in §15.247, the radio frequency power that is produced by the modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 kHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in §15.209(a), whichever results in the lesser attenuation. All other emissions outside these bands shall not exceed the general radiated emission limits specified in §15.209(a).

The antenna of the EUT is embedded in the printed circuit board and therefor does not allow for direct attachment to the antenna. All spurious measurements were made through radiated emissions testing.

The resolution bandwidth was set to 100 kHz, and the video bandwidth (VBW) was set > RBW. A scan was performed up to the tenth harmonic to ensure that all harmonics/spurs were at least 20 dB down from the highest emission level within the authorized frequency bands and below the general limits in the restricted bands. The results of this test are shown in Table 1.

3.5 Transmitter Spurious Emission Data:

Antenna Conducted Test per §15.247(c)

The data shown below lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Table 3.5 - 1: Antenna Conducted Emissions

Note: The antenna for the EUT is embedded in the printed circuit board. This test was not performed. All emissions were measured as a field strength and reported in Table 2.

TEST PERSONNEL:

Tester Signature

Jeremy Pickens / Project Engineer
Typed/Printed Name

3/2/98
Date

Radiated Emission Test per §15.247(c)

The data shown below lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Table 3.5 - 2: Radiated Spurious Emissions, 30 – 1000 MHz

Company: Robertshaw
Model: Tank Level Monitor

Notes: Initial Results

Date: 02/24/98
Tested by: Jim McDonald
Test Distance: 3
Job Number: J98*4378

Standard: FCC Part 15 15.247

EUT Orientation	Frequency (MHz)	Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-amp Factor (dB)	Average Factor (dB)	Net (dBuV/m)	Limit (dBuV/m)	Margin (dB)
x	102.620	43.7	10.6	3.0	16.8	16.8	23.7	88.5	-64.8
x	205.240	35.8	10.1	4.4	16.6	16.8	16.9	88.5	-71.6
z	307.860	48.1	14.1	5.5	16.2	16.8	34.7	88.5	-53.8
y	307.860	47.7	14.1	5.5	16.2	16.8	34.3	88.5	-54.2
x	307.860	43.7	14.1	5.5	16.2	16.8	30.3	88.5	-58.2
x	410.480	37.0	16.4	6.4	16.2	16.8	26.8	88.5	-61.7
x	513.100	38.7	17.3	7.4	16.0	16.8	30.6	88.5	-57.9
z	615.720	47.9	18.6	8.2	16.3	16.8	41.6	88.5	-46.9
x	615.720	48.3	18.6	8.2	16.3	16.8	42.0	88.5	-46.5
y	615.720	44.9	18.6	8.2	16.3	16.8	38.6	88.5	-49.9
x	658.952	31.2	19.3	8.3	16.0	16.8	26.0	88.5	-62.5
x	718.340	41.2	19.8	8.7	16.4	16.8	36.5	88.5	-52.0
z	820.960	51.9	21.2	9.5	16.6	16.8	49.2	88.5	-39.3
y	820.960	51.1	21.2	9.5	16.6	16.8	48.4	88.5	-40.1
x	820.970	53.7	21.2	9.5	16.6	16.8	51.0	88.5	-37.5
x	971.594	32.9	22.4	10.7	16.0	16.8	33.3	88.5	-55.2

TEST PERSONNEL:

J McDonald
Tester Signature

Jim McDonald / EMC Technician
Typed/Printed Name

3/2/98
Date

Table 3.5 - 3: Radiated Spurious Emissions, 1 – 10 GHz

Company: Robertshaw
Model: 0625-0300 Transmitter

Notes: Initial Results

Date: 03/09/98
Tested by: Jim McDonald
Test Distance: 3
Job Number: J98004378

Standard: FCC Part 15 15.247

Antenna Polarity	Frequency MHz	Reading dB(uV)	Antenna Factor dB	Cable Loss dB	Pre-amp Factor dB	external Attenuation dB	Average Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
x	1026.20	55.7	25.9	1.5	38.1	10.0	16.8	38.2	54.0	-15.8
x	1128.82	52.1	26.1	1.6	37.5	10.0	16.8	35.4	54.0	-18.6
x	1231.44	55.4	26.3	1.6	37.4	10.0	16.8	39.0	54.0	-15.0
x	1539.29	54.3	27.0	1.8	37.2	10.0	16.8	39.0	54.0	-15.0
x	1847.16	74.7	28.3	1.9	37.2	10.0	16.8	60.9	88.5	-27.6
x	2461.00	53.6	30.2	2.2	36.8	10.0	16.8	42.4	88.5	-46.1
x	2770.00	57.2	31.0	2.3	36.6	10.0	16.8	47.1	54.0	-6.9
z	3694.00	52.5	33.1	2.9	36.7	10.0	16.8	44.9	54.0	-9.1
y	4310.00	50.8	34.0	3.2	35.9	10.0	16.8	45.3	54.0	-8.7
z	4310.00	48.8	34.0	3.2	35.9	10.0	16.8	43.3	54.0	-10.7
z	4617.00	52.3	34.1	3.4	36.2	10.0	16.8	46.8	54.0	-7.2
x	4925.00	32.7	34.9	3.5	36.2	10.0	16.8	28.1	54.0	-25.9
y	5541.45	47.7	35.4	3.9	35.9	10.0	16.8	44.3	54.0	-9.7

TEST PERSONNEL:

J Mc Donald
Tester Signature

Jim McDonald / EMC Technician
Typed/Printed Name

3/2/98
Date

3.6 AC Power Line-Conducted Emissions per §15.207

For AC powered devices, line-conducted emissions testing is performed based on the requirements in §15.207.

Table 3.5 - 4: Power Line Conducted Emissions

Note: This test was not required because the EUT does not connect to the ac mains.

TEST PERSONNEL:

Tester Signature

Jeremy Pickens / Project Engineer
Typed/Printed Name

3/2/98
Date

3.7 *Power Spectral Density, §15.247(d)*

For direct sequence systems, the peak power spectral density conducted from the intentional radiator shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Attached is a plot that shows the power spectral density. This EUT does not have an antenna port as the antenna is embedded in the printed circuit board. This measurement was made with the azimuth of the turntable and the height of the measuring antenna are such that the highest emission is detected.

The resolution bandwidth is set to 3 kHz, the span is set to 1.5 MHz, and the sweep time is 500 seconds. The highest peak field strength was measured to be 83.2 dB(μV/m) which converts to –11 dBm when considering measurement distance and transmit antenna gain. See Figure 3.7-1 for plot.

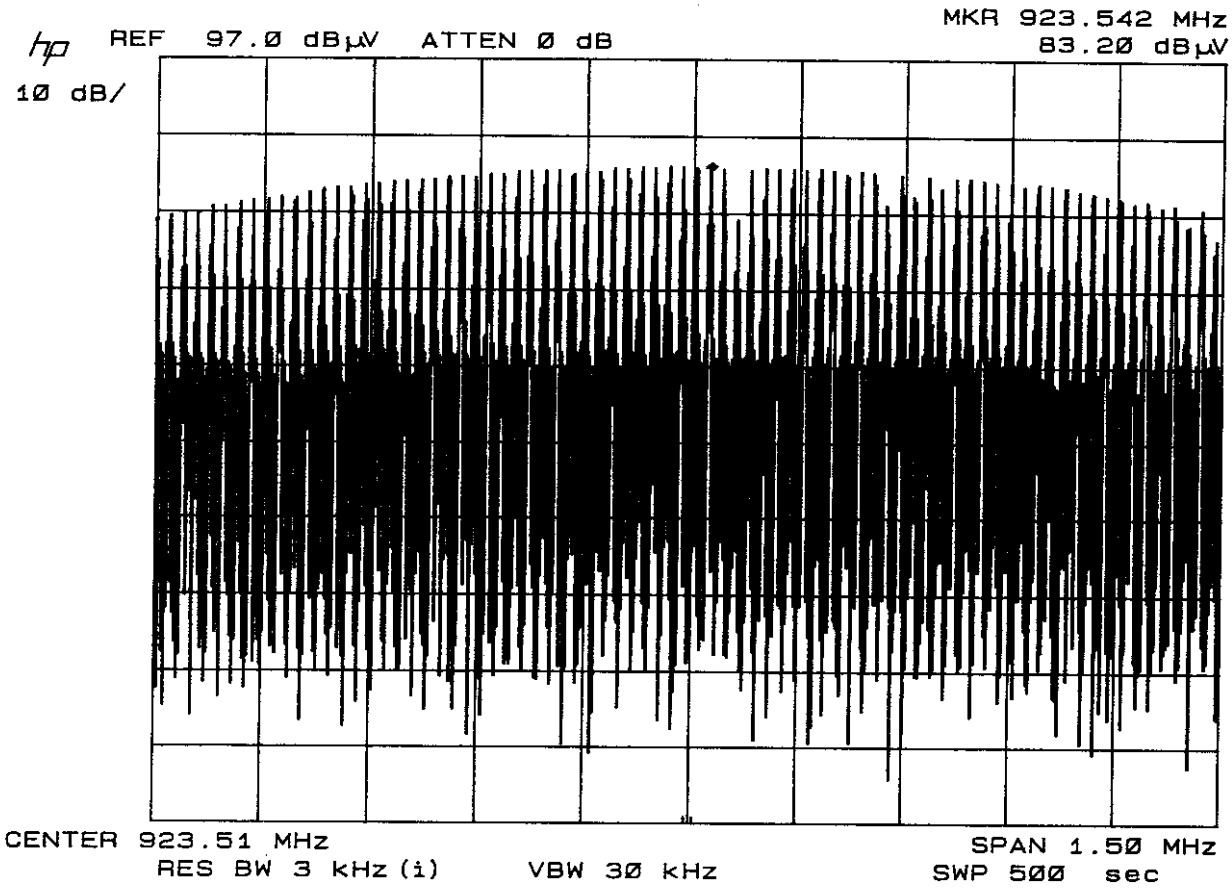

Figure 3.7-1: Power Spectral Density Plot

3.8 Radiated and Line-Conducted Emission Configuration Photographs

Figure 3.8-1: Worst Case Radiated Emission, Front View

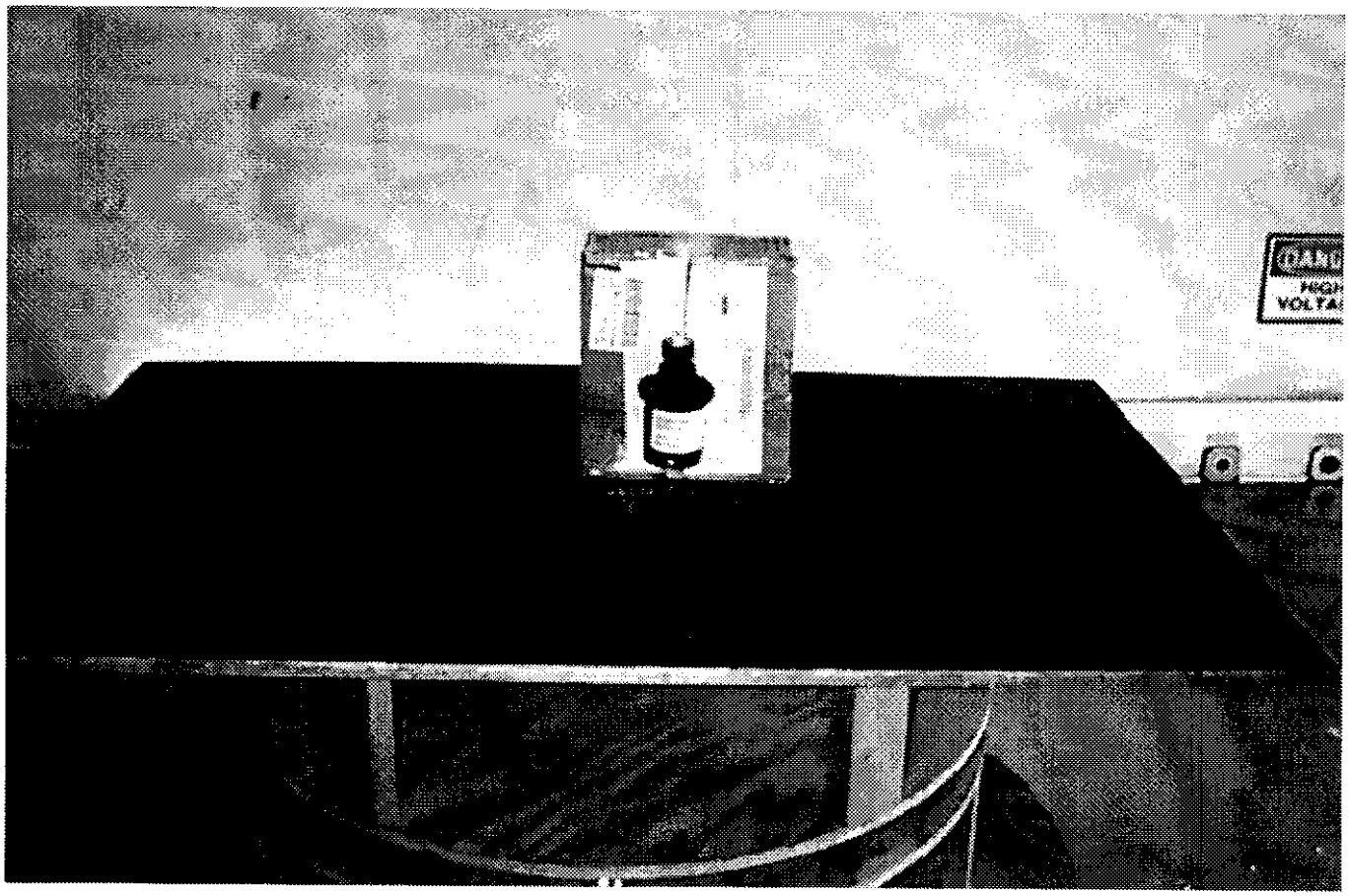

Figure 3.8-2: Worst Case Radiated Emission, Rear View