FCC, PART 15, SUBPART C

CERTIFICATION REPORT

For The RTR-4 Wireless Imager Transmitter

Part Number: **120523**

FCC ID: **LPRRTR-4418M** (PENDING)

PREPARED FOR:

Science Application International Corporation
10260 Campus Point Drive
San Diego, CA 92121

PREPARED ON **MARCH 14, 2000**

REPORT NUMBER 20-036

This report has been prepared in accordance with all applicable requirements of ANSI C63.4-1992

DOCUMENT HISTORY

REVISION	DATE	COMMENTS	
-	3/14/00	Prepared By:	Wm. Morton
-	3/14/00	Reviewed By:	A. Smith
-	3/14/00	Initial Release By:	J. L. Griffin

NOTE: Nemko EESI, Inc. hereby makes the following statements so as to conform to Chapter 10 (Test Reports) Requirements of ANSI C63.4 (1992) "Methods and Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz":

- The unit described in this report was received at Nemko EESI, Inc.'s facilities on February 11, 2000. Testing was performed on the units described in this report February 11–24, 2000.
- The Test Results reported herein apply only to the units actually tested, and to substantially identical units.
- This test report must not be used by the client to claim product endorsement by NVLAP or any agency of the U.S. Government.

TABLE OF CONTENTS

DOCUMENT HISTORY ii

CERTIFICATION iv

1. ADMINISTRATIVE DATA AND TEST SUMMARY 1
- 1.1 Administrative Data 1
- 1.2 FCC Test Requirements 1
- 1.3 FCC Test Summary 2

2. SYSTEM DESCRIPTION AND CONFIGURATION 3
- 2.1 Description of EUT 3
- 2.2 System Components and Power Cables 4
- 2.3 Device Interconnection and I/O Cables 5
- 2.4 Design Modifications for Compliance 5

3. DESCRIPTION OF TEST SITE AND EQUIPMENT 5
- 3.1 Description of Open Area Test Site 5
- 3.2 Test Equipment 6

4. DESCRIPTION OF TESTING METHODS 6
- 4.1 Introduction 6
- 4.2 Configuration and Methods of Measurements for Radiated Emissions 8
- 4.3 Test Calculations In Accordance With §15.231 11

5. TEST RESULTS 12
- 5.1 Radiated Emissions Test Data - §15.209 12
- 5.2 Radiated Emissions Test Data - §15.231 13
- 5.3 Duty Cycle - §15.231 14
- 5.4 Occupied Bandwidth Test Results - §15.231 19

EXHIBITS
- Figure 1. General EUT Test Setup Diagram 7
- Figure 2. Radiated Emissions Frequency ID Test Setup Diagram 9
- Figure 3. Radiated Emissions (OATS) Test Setup Diagram 10

APPENDICES
- Conducted & Radiated Emissions Measurement Uncertainties A-1
- Nemko EESI, Inc.'s Test Equipment & Facilities Calibration Program B-1

CERTIFICATION

The Radio Frequency Interference (RFI) testing, data evaluation and this report have been prepared by Nemko EESI, Inc., an independent electromagnetic compatibility consulting and test laboratory.

The testing and data collection were accomplished in accordance with the requirements of the ANSI, C63.4-1992 standard and the applicable sections of FCC, Part 15, Subpart C for intentionally radiating equipment. Refer to the Administrative Summary for a description of the test sample.

I certify the data, data evaluation and equipment configuration herein to be a true and accurate representation of the sample's radio frequency interference emission characteristics, as of the test date(s), and for the design of the test sample utilized to compile this report.

This report, in its entirety, consists of 31 pages.

J. L. Griffin
Director of Laboratory Operations

1. ADMINISTRATIVE DATA AND TEST SUMMARY

1.1 Administrative Data

CLIENT: Science Application International Corporation
10260 Campus Point Drive
San Diego, CA 92121
(858) 826-5122
(858) 826-9718 – fax

CONTACT: Greg Dahlvig

DATE(S) OF TEST: February 11–24, 2000

TEST SPECIFICATION: FCC, Part 15, Subpart C, for intentional radiators

EQUIPMENT UNDER TEST (EUT): RTR-4 Wireless Imager Transmitter
Part Number: 120523
Serial Number: 0102
FCC ID Number (pending): LPRRTR-4418M

EUT transmitter fundamental frequency: 418 MHz

1.2 FCC Test Requirements

FCC Rule	*Description*
15.31	Measurement Standards
15.33	Frequency Range of Radiated Measurements
15.203	Antenna Requirements
15.205	Restricted Bands
15.207	AC Conducted Emissions
15.209	General Radiated Emissions
15.231	Transmission Deactivation Time

1.3 FCC Test Summary

FCC Section	*Notes*	*Results*
15.31	General test requirements. The EUT uses a fixed frequency at 418MHz only.	**N/A**
15.33	Requirement to test to the 10th Harmonic (see §15.231 datasheet)	**PASS Section 5.2**
15.203	The EUT has a custom antenna that does not allow the end-user to replace with another antenna. This requirement is met.	**N/A**
15.205	Requirement is met (see §15.231 datasheet)	**PASS Section 5.2**
15.207	The EUT is battery powered only, therefore no conducted emissions tests were performed.	**N/A**
15.209	Requirement is met (see §15.209 datasheet)	**PASS Section 5.1**
15.231(a)(1) and (2)	Transmission Deactivation Time	**PASS Section 5.3**
15.231(b)	Requirement is met (see §15.231 datasheet)	**PASS Section 5.2**
15.231(c)	Requirement is met (see §15.231 datasheet)	**PASS Section 5.4**
15.231(b) and 15.35(c)	These sections allow for the averaging data collection method. See the notes in Section 4 of this test report along with the data plots in Section 5.3.	**Section 5.2**

J. L. Griffin, Nemko EESI, Inc.

2. SYSTEM DESCRIPTION AND CONFIGURATION

2.1 Description of EUT

The Equipment Under Test is an RF Wireless Accessory package for the RTR-4 Portable Digital X-Ray System. The RTR-4 system (a previously tested FCC compliant system) is designed to be used by law enforcement and security professionals to quickly detect, identify, and evaluate the contents of suspicious packages, objects and transport devices. In practice, the suspicious object in question is placed between the X-ray source and Imager units, then the operator uses the remote controller unit to send a trigger message to the X-ray source and a message to the imager to receive the X-Ray image. The X-Ray image is then sent to the controller unit for operator inspection.

The RF Wireless Accessory package is designed to replace the interconnect cabling of the existing RTR-4 system. The Wireless Accessory package allows for ease of movement and allows the operator and other personnel to remain at a safe distance from the potentially dangerous item being evaluated (some terrorist explosive devices are designed to detonate in the presence of an x-ray source). The Wireless Accessory Package consists of four modules as follows:

1. 418MHz Transmitter (part #120523, attaches to Imager, FCC Certification requested)
2. 418MHz Receiver (attaches to X-Ray source; approved via Declaration of Conformity procedures)
3. 2.432 GHz Transceiver (part #120550, attaches to Controller; FCC Certification requested in separate application)
4. 2.432 GHz Transceiver (attaches to Imager, No FCC action requested)

The wireless accessory system uses two EZY2400 2.4GHz spread spectrum Ethernet modem units (from OTC Telecommunications, Inc.), a 418MHz transmitter, and a 418MHz Receiver; one of the 2.432 GHz units is an unmodified off-the-shelf unit (FCC ID: MKZAZY2460SWG). The Wireless Controller and Imager kits each use the Ethernet modem with a manufacturer-supplied ¼ wavelength sleeve dipole antenna designed for omni-directional use. The Ethernet modem was repackaged to include a 12V to 5V DC-DC converter. A battery and switching power supply provides 12VDC to the Imager and 5VDC to the OTC Ethernet modem. The 418MHz transmit and receive antennae are identical and interchangeable ¼ wavelength whips with omni-directional patterns. The 418MHz transmitter and receiver units are a hybridized monolithic module, purchased "off the shelf" from Linx Technologies.

During testing, the EUT Controller was set to a factory test mode to "Acquire Many Images." This mode kept the EUT system exercised at maximum levels during all tests. Anticipated real-life use of the system is 2 or 3 images per day from the Imager, and the Ethernet modem would be silent the remainder of the time. The 418MHz transmission to the X-ray source only occurs before an image is acquired.

2.2 System Components and Power Cables

DEVICE	MANUFACTURER MODEL # SERIAL #	POWER CABLE
EUT- RTR-4 Wireless Imager Transmitter	Science Application International Corporation Part Number 120523 N/A	N/A
Imager	Science Application International Corporation RTR-4 N/4602 701-08	N/A (battery-powered)
Imager Transceiver	OTC Telcom AirEZY2460-SWG 2W19X1464	N/A (battery-powered)
Controller	Science Application International Corporation RTR-4 4602 701-08	2m, unshielded, 18 AWG, 3-wire, IEC connector
Controller Transmitter	Science Application International Corporation Part Number 120550 0102	N/A (battery-powered)
X-Ray Receiver	Science Application International Corporation RTR-4 0102	N/A (battery-powered)
X-Ray Source	Golden Engineering XR200 0750	N/A (battery-powered)
Monitor	Microdata Distribution Inc. N/A N/A	2m, unshielded, 18AWG, 3-wire, IEC connector
Trackball	Logitech T-CL13 P/N 804269-0000	N/A
Printer	Hewlett Packard C3990A JPHJ007769	2m, unshielded, 18 AWG, 3-wire, IEC connector

2.3 Device Interconnection and I/O Cables

CONNECTION	I/O CABLE
418MHz Transmitter to Imager	30cm, shielded, 26 AWG, Cat 5 cable, 10-pin circular connector
418MHz Transmitter to Imager	30cm, shielded, Belden-M 8444 cable, 6-pin circular connector
418MHz Transmitter to X-Ray Source	30cm, shielded, Belden-M 8444 cable, 4-pin circular connector
2.4GHz Transceiver to Controller	30cm, shielded, Cat 5 cable, 26 AWG, 10-pin circular connector to hardwired
2.4GHz Transceiver to 418MHz Transmitter	*(I/O):* 5cm, unshielded, 8-wire, RJ45 cable and connectors *(Power):* 5cm, unshielded, 2-wire, 18 AWG, ¼" plug
Controller to Trackball	2.5m, shielded, 26 AWG, DB9 (via 6-pin mini-DIN) connector
Controller to Printer	2m, shielded, 24 AWG, DB25 to Centronix 36 connector
Controller to Monitor	1.5m, shielded, 24 AWG, HD DB15 connectors
Controller (RJ11)	2m, unshielded, RJ11 telco cable and connectors (unterminated)

2.4 Design Modifications for Compliance

No design modifications were made to this EUT during testing.

3. DESCRIPTION OF TEST SITE AND EQUIPMENT

3.1 Description of Open Area Test Site

The test site is located at 11696 Sorrento Valley Road, Suite F, San Diego, CA 92121. The site is physically located 18 miles Northwest of downtown San Diego. The general area is a valley 1.5 miles east of the Pacific Ocean. This particular part of the valley tends to minimize ambient levels, i.e. radio and TV broadcast stations and land mobile communications. The ten-meter site is located behind the office/lab building. It conforms to the normalized site attenuation limits and construction specifications as set in the EN 55022 (1987), CISPR 16 and 22 (1985) and ANSI C63.4-1992 documents. The site attenuation characteristics are verified for compliance every year, and the site was last calibrated on August 14, 1999. The site was last registered with the Federal Communications Commission on December 15, 1999, FCC Registration Number 90579.

3.2 Test Equipment

The following test equipment was used to collect data for this report. All devices used were of current calibration and of the type required in the applicable documents section of this report.

DEVICE	MANUFACTURER	MODEL	ASSET #	CAL. DATE	CAL. DUE
Quasi-Peak Adapter	Hewlett Packard	85650A	538	9/17/99	2/17/00
Spectrum Analyzer Display	Hewlett Packard	85662A	537	9/17/99	2/17/00
Spectrum Analyzer	Hewlett Packard	8566B	711	9/17/99	2/17/00
RF Preselector	Hewlett Packard	85685A	673	7/22/99	7/22/00
Antenna, Log Periodic	EMCO	3146	111	8/03/99	8/03/00
Antenna, Biconical	EMCO	3104	115	5/17/99	5/17/00
Open Area Test Site (OATS)	Nemko EESI, Inc.	North	9998	8/14/99	8/14/00

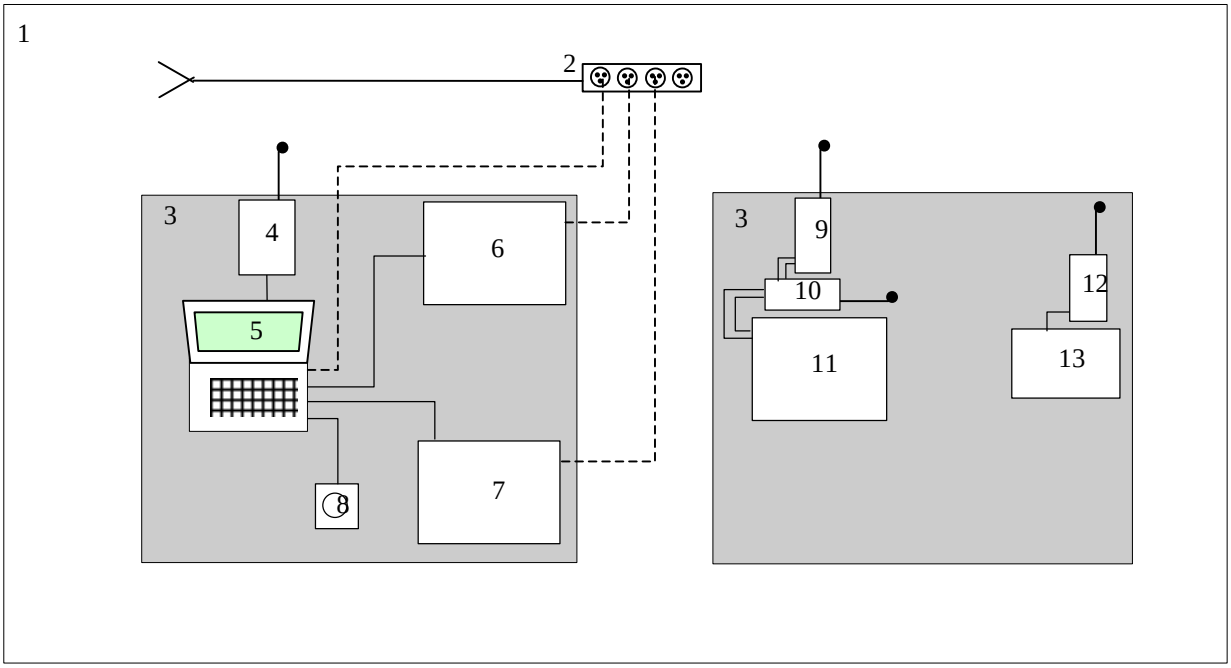
4. DESCRIPTION OF TESTING METHODS

4.1 Introduction

As required in 47 CFR, Parts 2 and 15, the methods employed to test the radiated and conducted emissions (as applicable) of the EUT are those contained within the American National Standards Institute (ANSI) document C63.4-1992, titled "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz." All applicable FCC Rule Sections that provide further guidance for performance of such testing are also observed.

For General Test Configuration please refer to Figure 1 on the following page.

Figure 1. General EUT Test Setup Diagram



NOT TO SCALE

CONFIGURATION LEGEND

1. Test Laboratory
2. AC Power for Devices
3. Non-Conducting tables 80 cm above ground plane
4. 2.4GHz Transceiver
5. RTR-4 Controller
6. Monitor
7. Printer
8. Trackball
9. 2.4GHz Transceiver for Imager
10. EUT: 418MHz Transmitter for Imager
11. Imager
12. Receiver for X-Ray Source
13. X-Ray Source

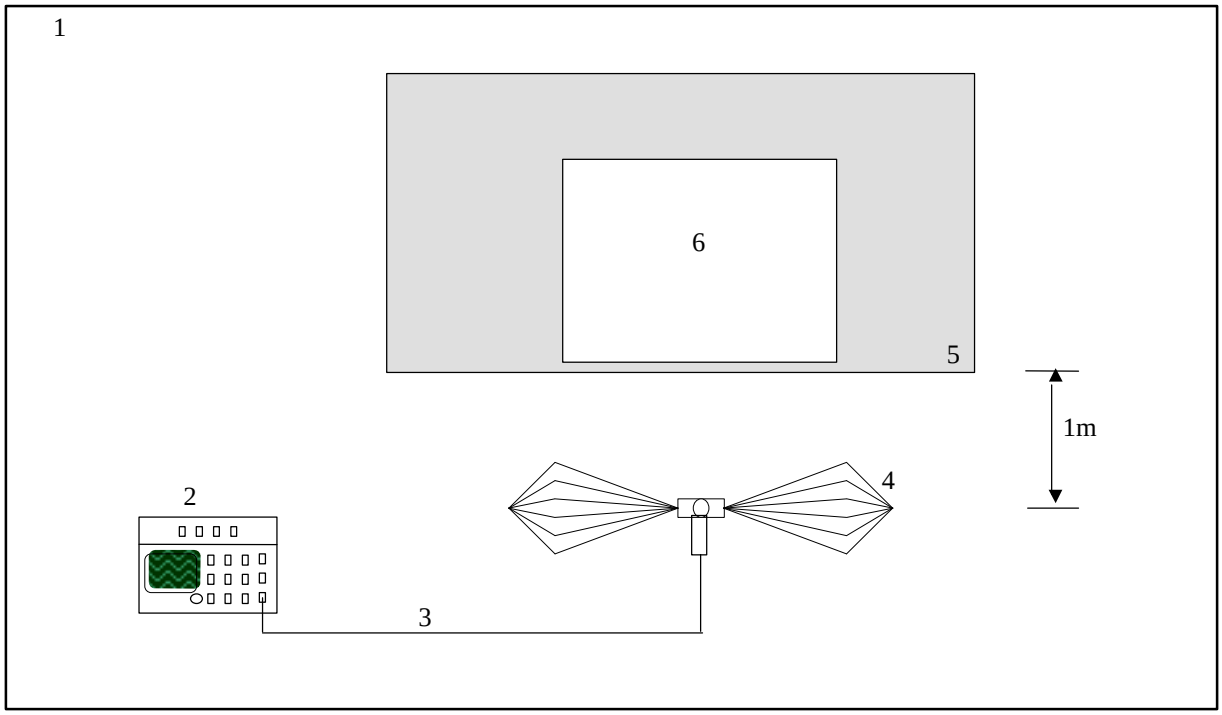
4.2 Configuration and Methods of Measurements for Radiated Emissions

Section 8 of ANSI C63.4 determines the general configuration and procedures for measuring the radiated emissions of equipment under test. Initially, the primary emission frequencies are identified inside the test lab by positioning a broadband receive antenna one meter from the EUT to locate frequencies of significant radiation. Normally this is done inside a shielded anechoic chamber to eliminate ambients. Next, the EUT and associated system are placed on a turntable on an 10 meter open area test site (registered with the FCC in accord with its Rules and ANSI C63.4) and the receive antenna is located at a distance of ten or three meters from the EUT.

The EUT and associated system are configured to operate in a "normally operating" mode. To ensure that the maximum emission at each discrete frequency of interest is observed, the receive antenna is varied in height from one to four meters and rotated to produce horizontal and vertical polarities, and the turntable is also rotated to determine the worst emitting configuration.

For Frequency ID and Radiated Emissions test configurations please refer to Figures 2 and 3 on the following pages.

Figure 2. Radiated Emissions Frequency ID Test Setup Diagram

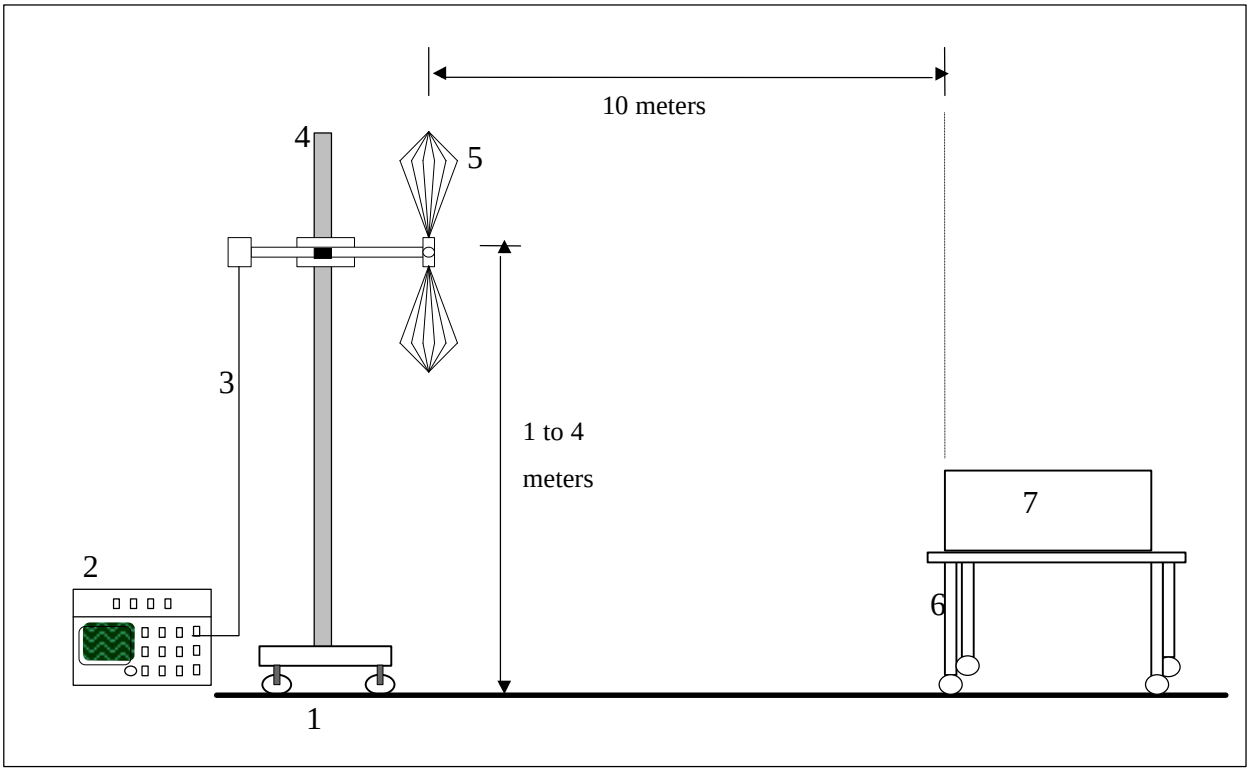


NOT TO SCALE

CONFIGURATION LEGEND

1. Test Laboratory
2. Spectrum Analyzer with Quasi-Peak Adapter
3. Coax interconnect from Antenna to Spectrum Analyzer
4. Receive Antenna (basic relative position)
5. Non-Conducting table 80 cm above ground plane
6. EUT and Associated System

Figure 3. Radiated Emissions (OATS) Test Setup Diagram



NOT TO SCALE

CONFIGURATION LEGEND

1. Ground plane (11 X 17 meters)
2. Spectrum Analyzer with Quasi-Peak Adapter
3. Coax interconnect from Receive Antenna to Spectrum Analyzer
4. Antenna Mast with motorized mounting assembly
5. Receive Antenna (basic relative position)
6. Non-Conducting table 80 cm above ground plane
7. EUT and associated system

4.3 Test Calculations In Accordance With §15.231

In accordance with §15.231(b) of the CFR 47, the following calculations were made for the EUT intentional radiator limts:

$$20\log\left[\left(\frac{418-260}{470-260}\right)(12.500 - 3750) + 3750\right] \text{dB}\mu\text{V/m}$$

In accordance with §15.231(c) of the CFR 47, Occupied Bandwidth measurements were made as follows:

0.25% of 41 8MHz = 1.045 MHz
(Example: 142 kHz < 1.045 MHz ⇒ PASS)

For further details please refer to the Data Plots in Section 5.5 of this test report.

The EUT's Duty Cycle correction factor was calculated as follows:

A message is 3 words, separated by approximately 60 msec, each word being approximately 43.6 msec long. Each word starts with a 12-bit (thin bits) synchronization preamble. A 1.96 msec pause and then 66 data bits follow this preamble. The bits are defined as follows:

Data Bit duration = 570 µsec (duration = sum of "on" time + "off" time)
Synchronization Bit duration = 400 µsec
Fat Bit "On" time = 400 µsec
Thin Bit "On" time = 200 µsec

"On" time schedule:

Preamble: 12 thin bits x 200 µsec = 2.4 msec
Data Bits: 66 fat bits x 400 µsec =26.4 msec ("worst case" duration)
28.8 msec

Duty Cycle Correction Factor:

20_{log} (On-time(msec) / 100 msec) = 20_{log} (28.8 / 100) = 10.8 dB

Message repetition: The message is sent once, each time that an image is requested. This occurs infrequently, since each image must be transmitted, examined and (likely) printed. It is also likely that the repeated images of the same object from the same direction are not useful, so the staging would likely be changed between images.

5. TEST RESULTS

5.1 Radiated Emissions Test Data - §15.209

Nemko EESI, Inc.
FCC, Part 15.209, Class 'A' Radiated Emissions Data Sheet
(10m Open Area Test Site)

Client: SAIC
EUT: RTR-4 Wireless Accessory (for Imager)
Model #: 120523

Conducted by: C. Pollard
Date of Test: 02-11-00
Frequency Range: 30-1000MHz

Frequency (MHz)	Spectrum Analyzer Reading (dBμV)	Antenna Polarization (V or H)	Amp. Gain & Cable Loss, Distance & Antenna Factor Correction for 10m (dB/m)	Total Interference Level Corrected for 10 m (dBμV/m)	Emission Spec. Limit at 10 m (dBμV/m)	Difference Margin (dB)
41.700	15.4	v	13.4	28.8	39.1	-10.3
50.119	22.8	v	13.5	36.3	39.1	-2.8
62.540	13.4	v	12.4	25.8	39.1	-13.3
75.115	20.1	v	9.8	29.9	39.1	-9.2
79.190	12.3	v	9.7	22.0	39.1	-17.1
112.700	15.4	v	16.7	32.1	43.5	-11.4
125.220	21.0	v	15.5	36.5	43.5	-7.0
137.760	21.8	v	15.4	37.2	43.5	-6.3
150.330	21.3	v	17.3	38.6	43.5	-5.0
162.870	17.8	v	19.1	36.9	43.5	-6.6
200.450	19.9	v	15.3	35.2	43.5	-8.3
225.500	22.9	v	15.8	38.7	46.4	-7.7
250.480	13.5	v	18.0	31.5	46.4	-14.9
263.100	16.6	v	18.2	34.8	46.4	-11.7
300.680	17.0	v	20.0	37.0	46.4	-9.4
313.200	13.4	v	19.9	33.3	46.4	-13.1
338.250	13.2	v	20.0	33.2	46.4	-13.2
363.320	10.4	h	20.4	30.8	46.4	-15.7
413.420	9.8	h	21.7	31.5	46.4	-14.9
476.070	16.3	v	24.2	40.5	46.4	-6.0
501.080	15.7	v	24.7	40.4	46.4	-6.0
526.070	18.4	v	24.8	43.2	46.4	-3.3
551.210	11.9	v	25.6	37.5	46.4	-8.9
840.906	12.9	v	31.1	44.0	46.4	-2.5

Test Conditions: Standard radiated emissions test set up on FCC registered open field site. The highest emissions for all antenna heights, polarities, and table orientations are the only emissions recorded.

5.2 Radiated Emissions Test Data - §15.231

Nemko EESI, Inc.
FCC, Part 15C, 15.231 Radiated Emissions Data Sheet
(3m Open Area Test Site)

Client: SAIC
EUT: RTR-4 Wireless Accessory (for Imager)
Model #: 120523

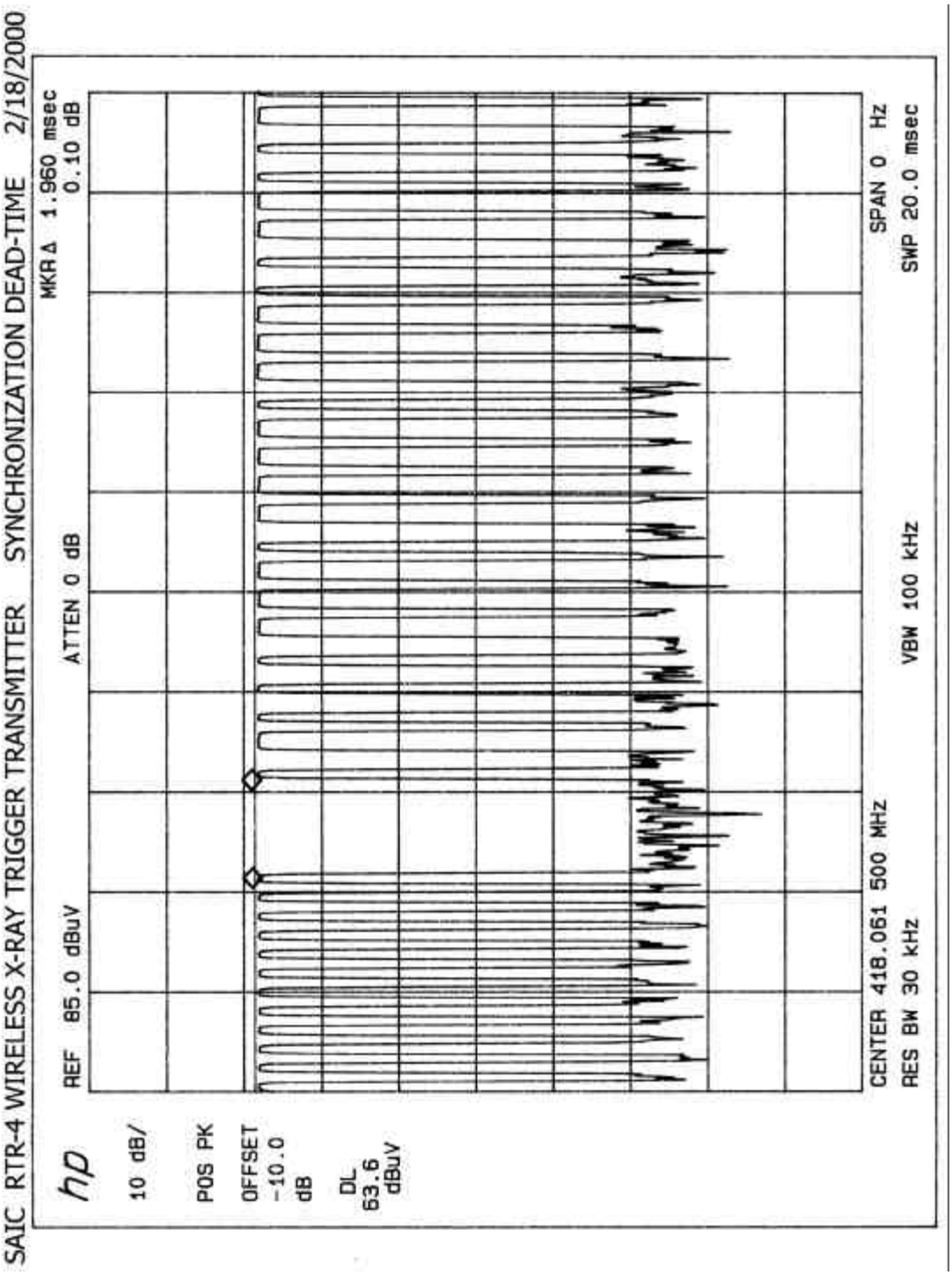
Conducted by: C. Pickard
Date of Test: 02-24-00
Test Distance, Amp. gain: 3 m, 0 dB

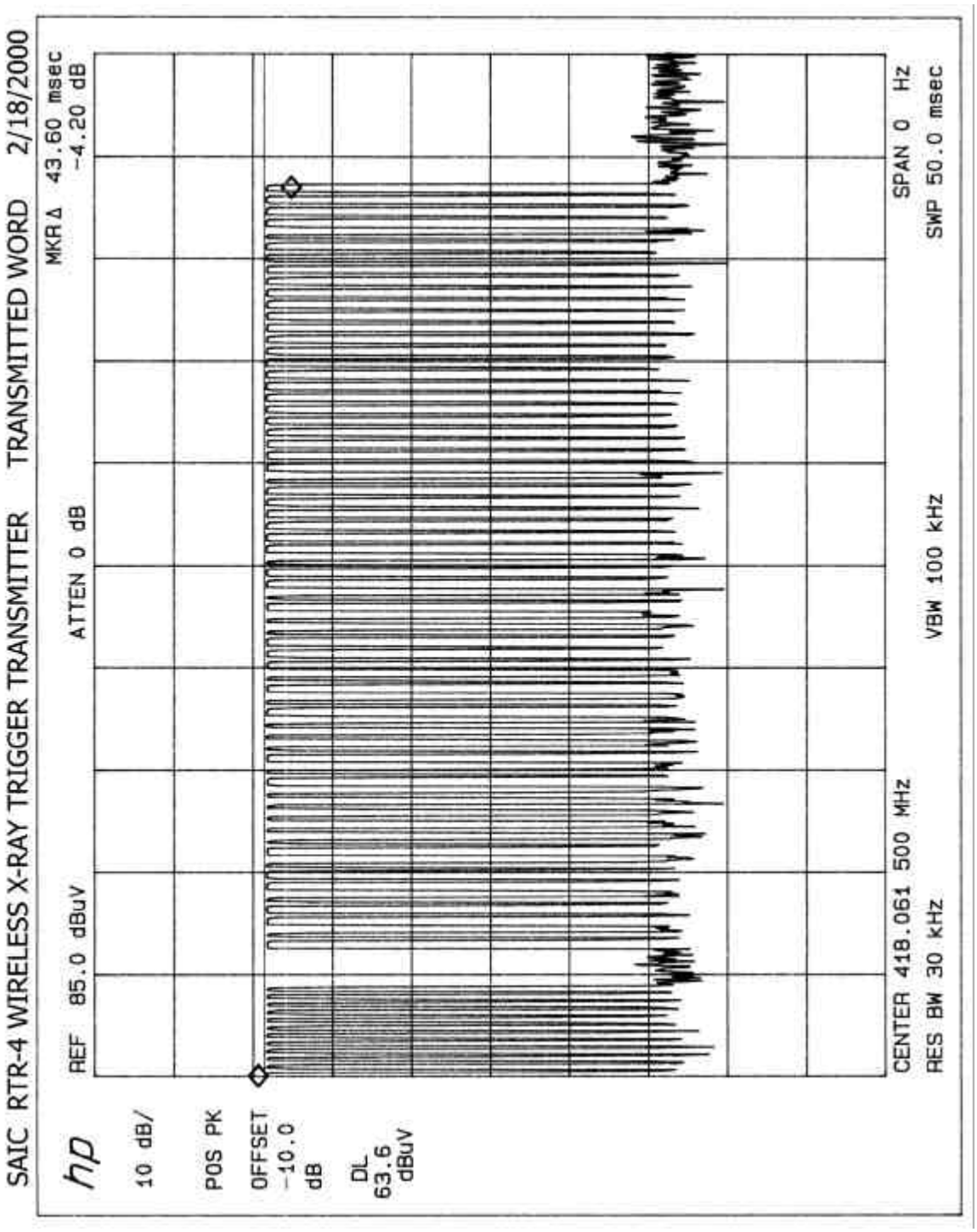
Frequency (MHz)	Spectrum Analyzer Reading at 3m (dBμV)	Antenna Position	f_O	Duty Cycle Correction Factor (dB)	Cable Loss (dB)	Antenna Factor (dB)	Total Interference Level at 3 m (dBμV/m)	Emission Spec. Limit at 3 m (dBμV/m)	Difference Margin (dB)
418.000	60.7	v	f_0	-10.8	6.3	16.3	72.5	80.3	-7.8

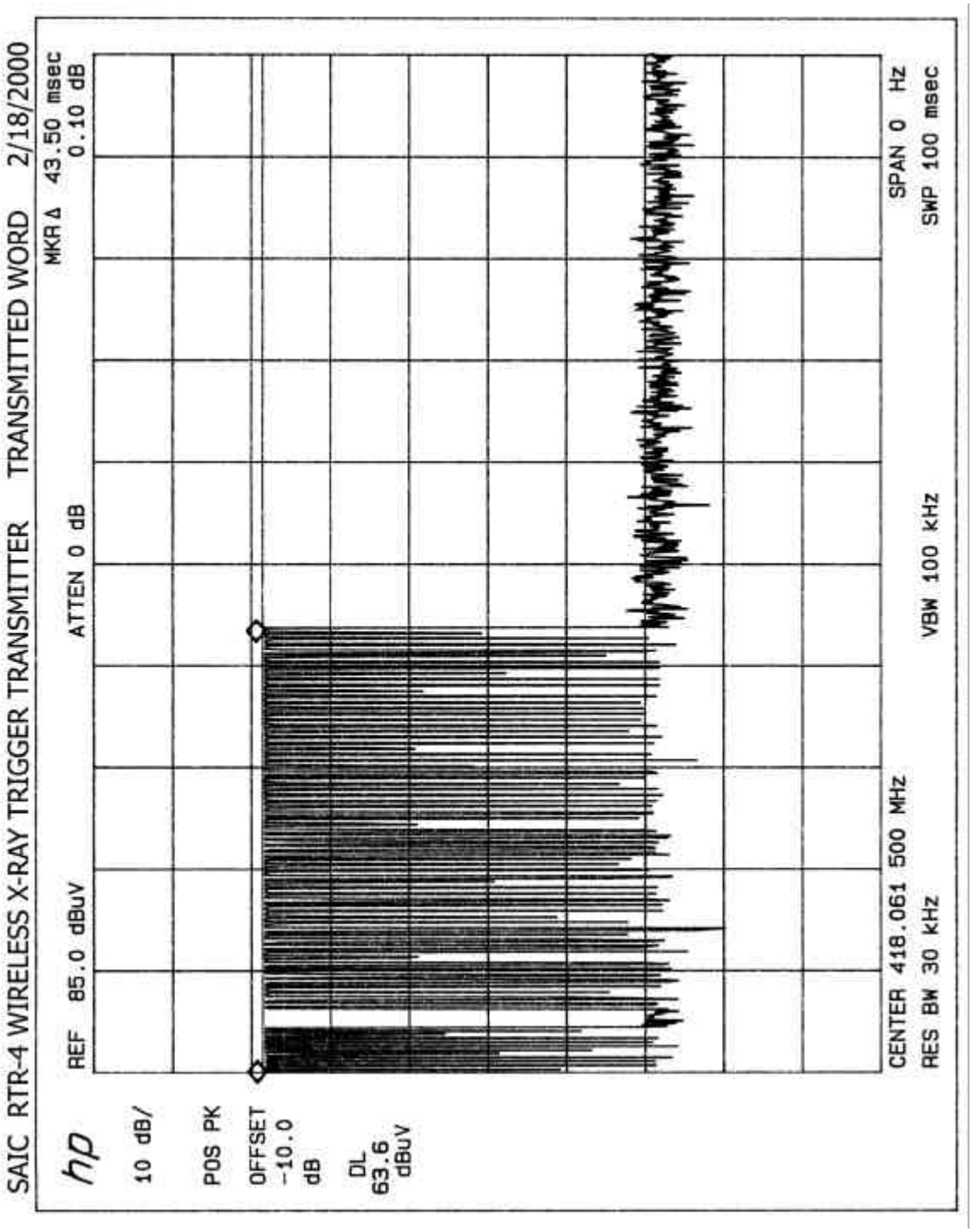
Note: No emissions were observed at harmonic frequencies (f_2-f_{10})

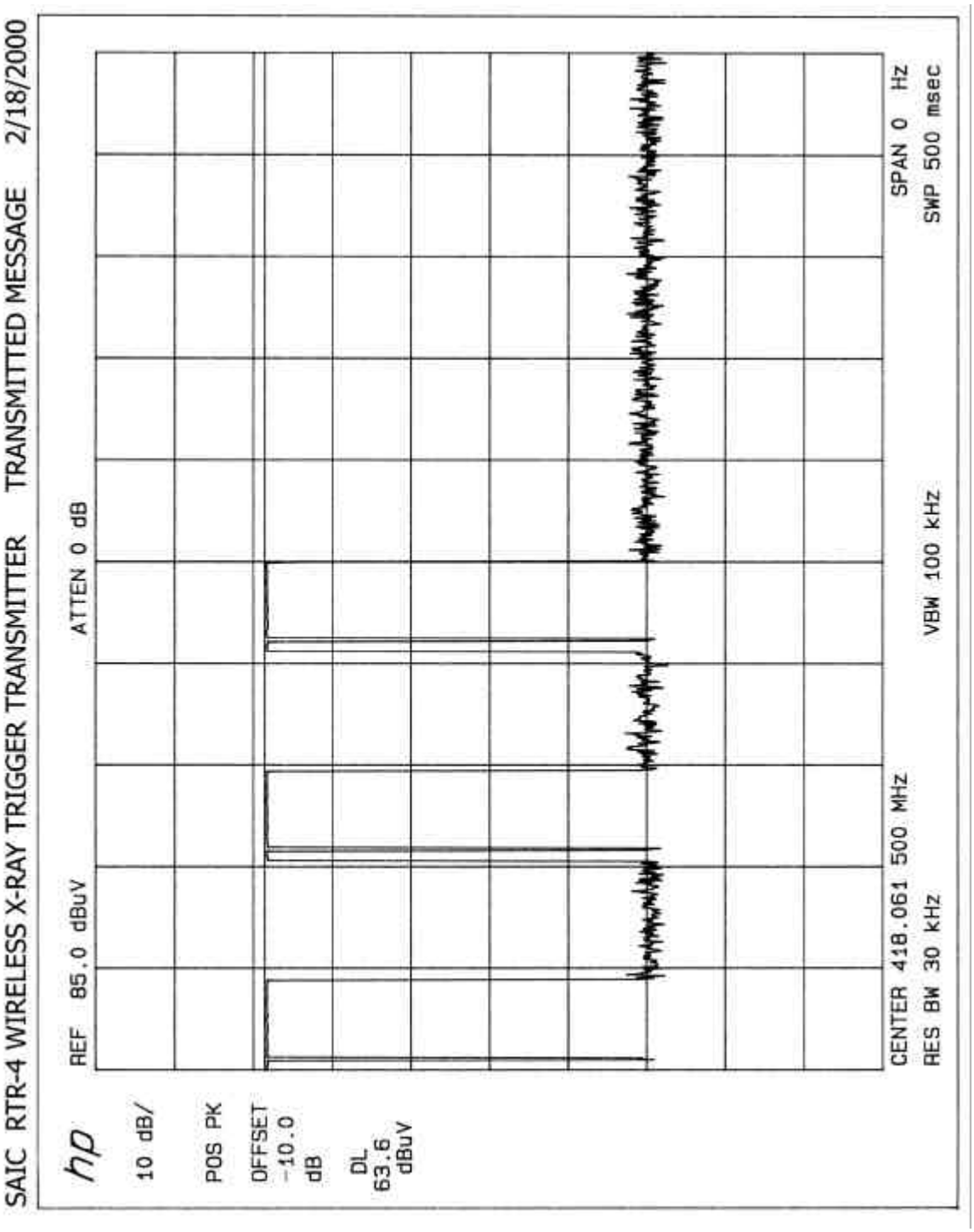
Test Conditions: Standard radiated emissions test set up on FCC registered open field site. The highest emissions for all antenna heights, polarities, and table orientations are the only emissions recorded.

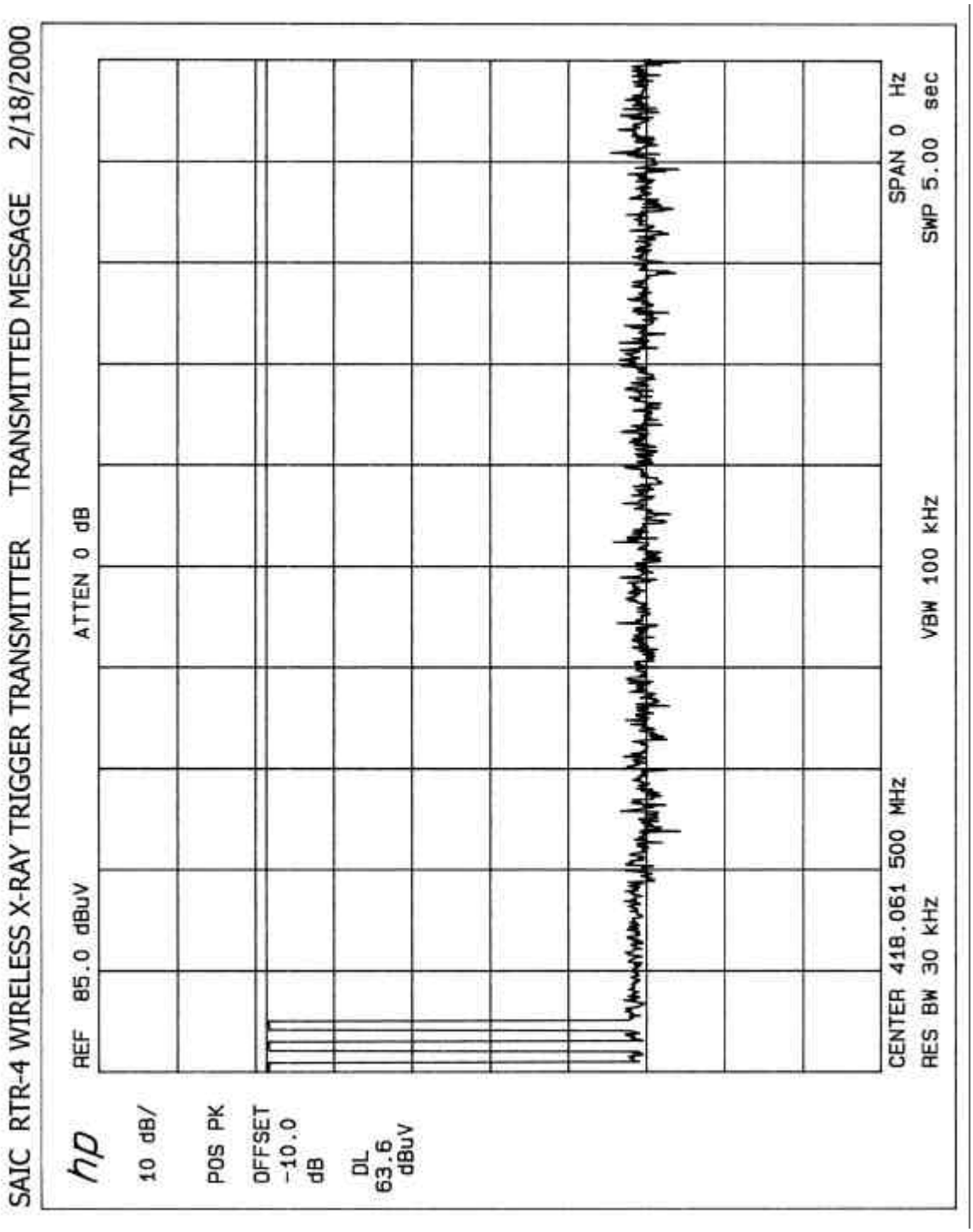
5.3 Duty Cycle - §15.231



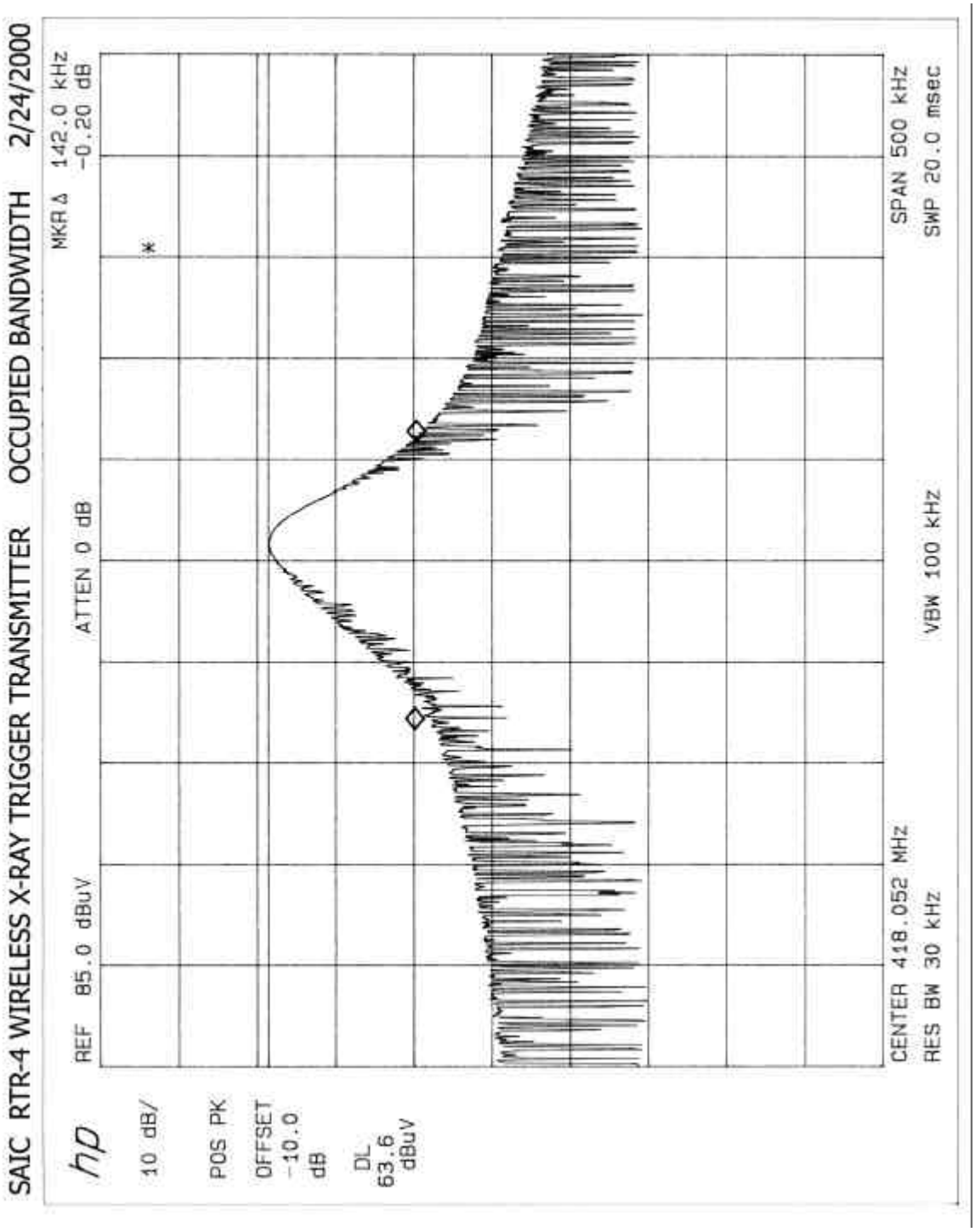

SAIC RTR-4 WIRELESS X-RAY TRIGGER TRANSMITTER TRANSMITTED WORD 2/18/2000
MKR Δ 43.60 msec
-4.20 dB
REF 85.0 dBuV
ATTEN 0 dB
10 dB/
POS PK
OFFSET
-10.0
dB
DL
63.6
dBuV
SPAN 0 Hz
SWP 50.0 msec
VBW 100 kHz
CENTER 418.061 500 MHz
RES BW 30 kHz

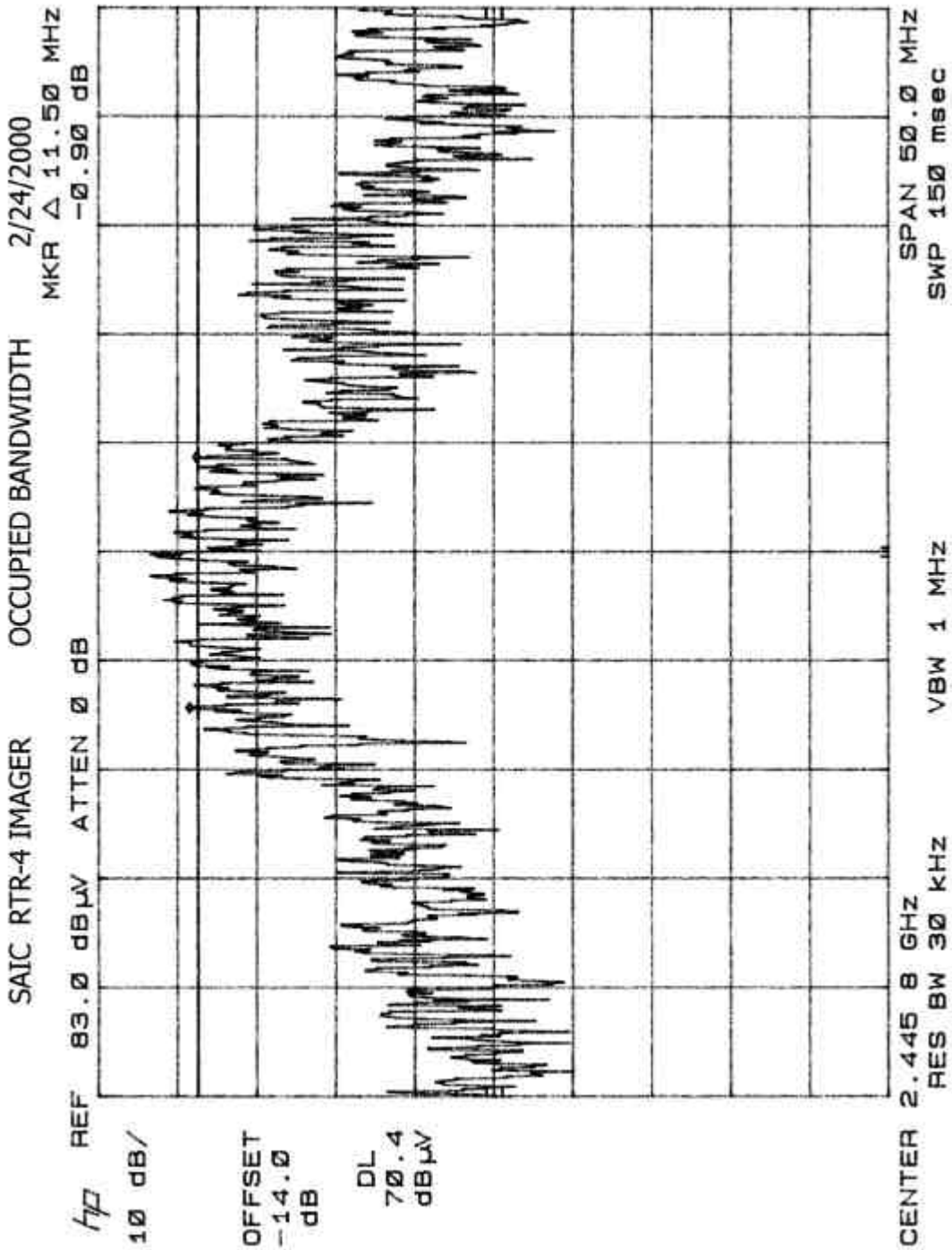

SAIC RTR-4 WIRELESS X-RAY TRIGGER TRANSMITTER TRANSMITTED WORD 2/18/2000
hp
10 dB/
REF 85.0 dBuV
POS PK
OFFSET -10.0 dB
DL 63.6 dBuV
ATTEN 0 dB
MKR Δ 43.50 msec
0.10 dB
CENTER 418.061 500 MHz
RES BW 30 kHz
VBW 100 kHz
SPAN 0 Hz
SWP 100 msec

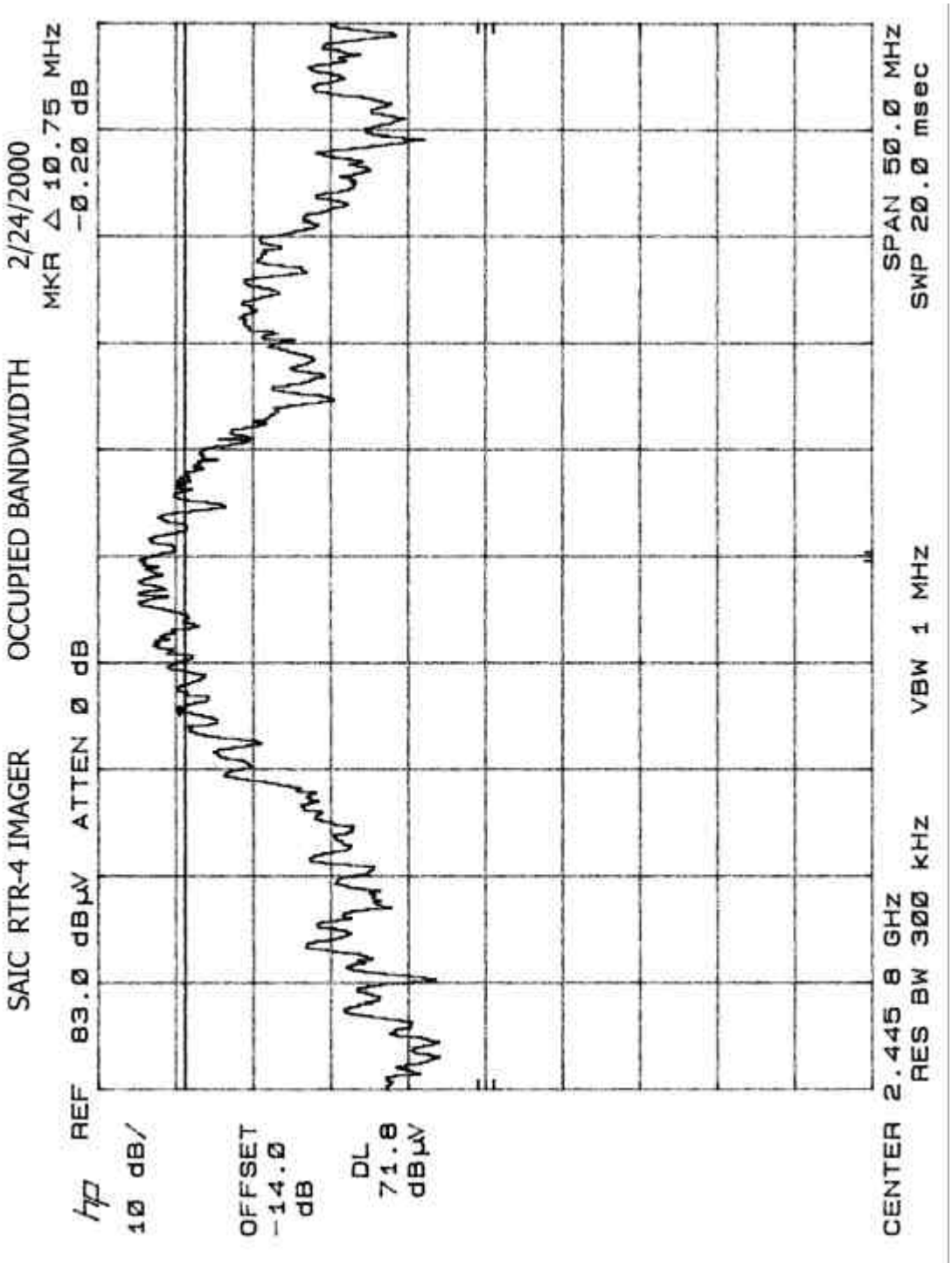

SAIC RTR-4 WIRELESS X-RAY TRIGGER TRANSMITTER TRANSMITTED MESSAGE 2/18/2000
hp
10 dB/
POS PK
OFFSET -10.0 dB
DL 63.6 dBuV
REF 85.0 dBuV
ATTEN 0 dB
CENTER 418.061 500 MHz
RES BW 30 kHz
VBW 100 kHz
SPAN 0 Hz
SWP 500 msec

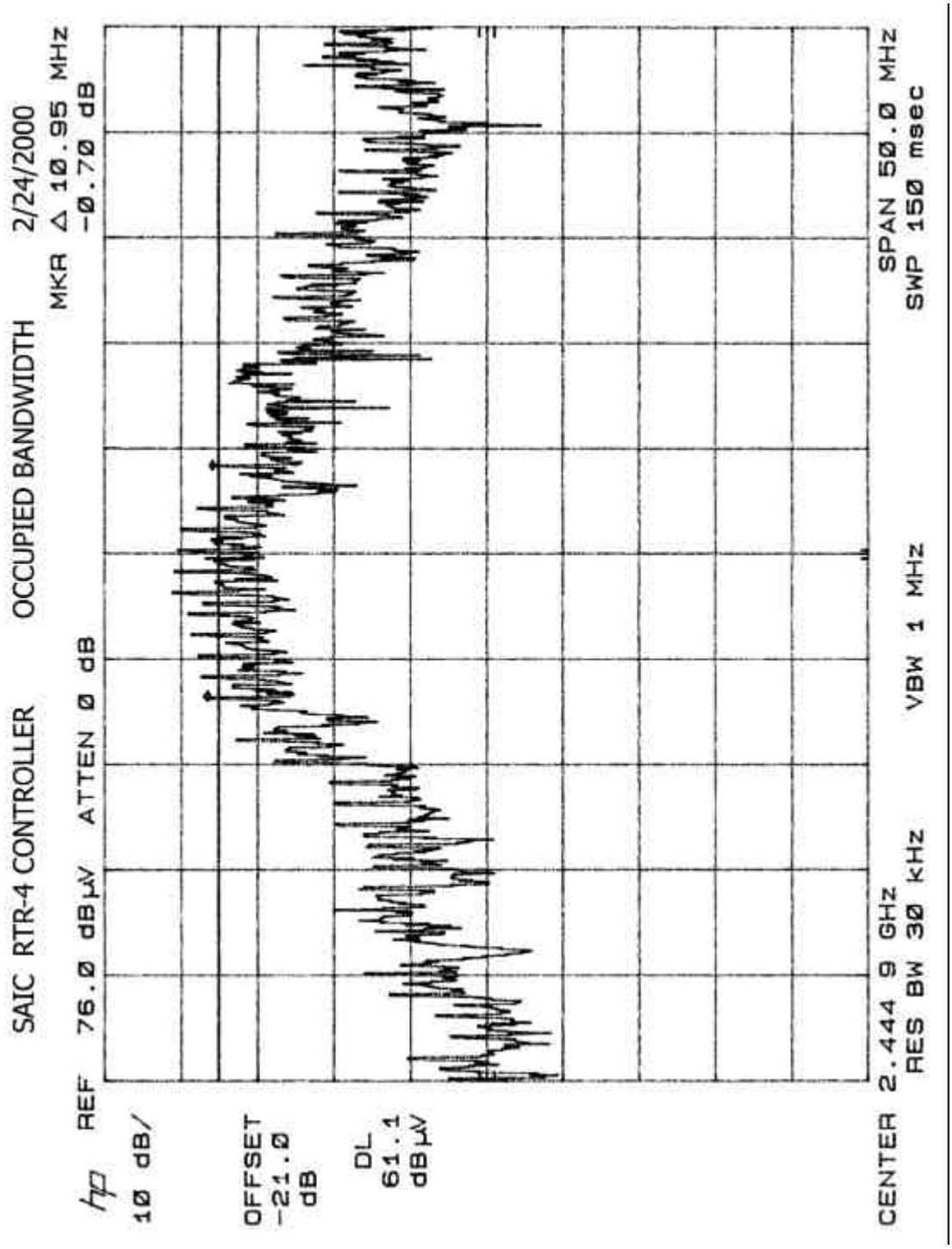

SAIC RTR-4 WIRELESS X-RAY TRIGGER TRANSMITTER TRANSMITTED MESSAGE 2/18/2000
hp
10 dB/
REF 85.0 dBuV
ATTEN 0 dB
POS PK
OFFSET -10.0 dB
DL 63.6 dBuV
CENTER 418.061 500 MHz
RES BW 30 kHz
VBW 100 kHz
SPAN 0 Hz
SWP 5.00 sec

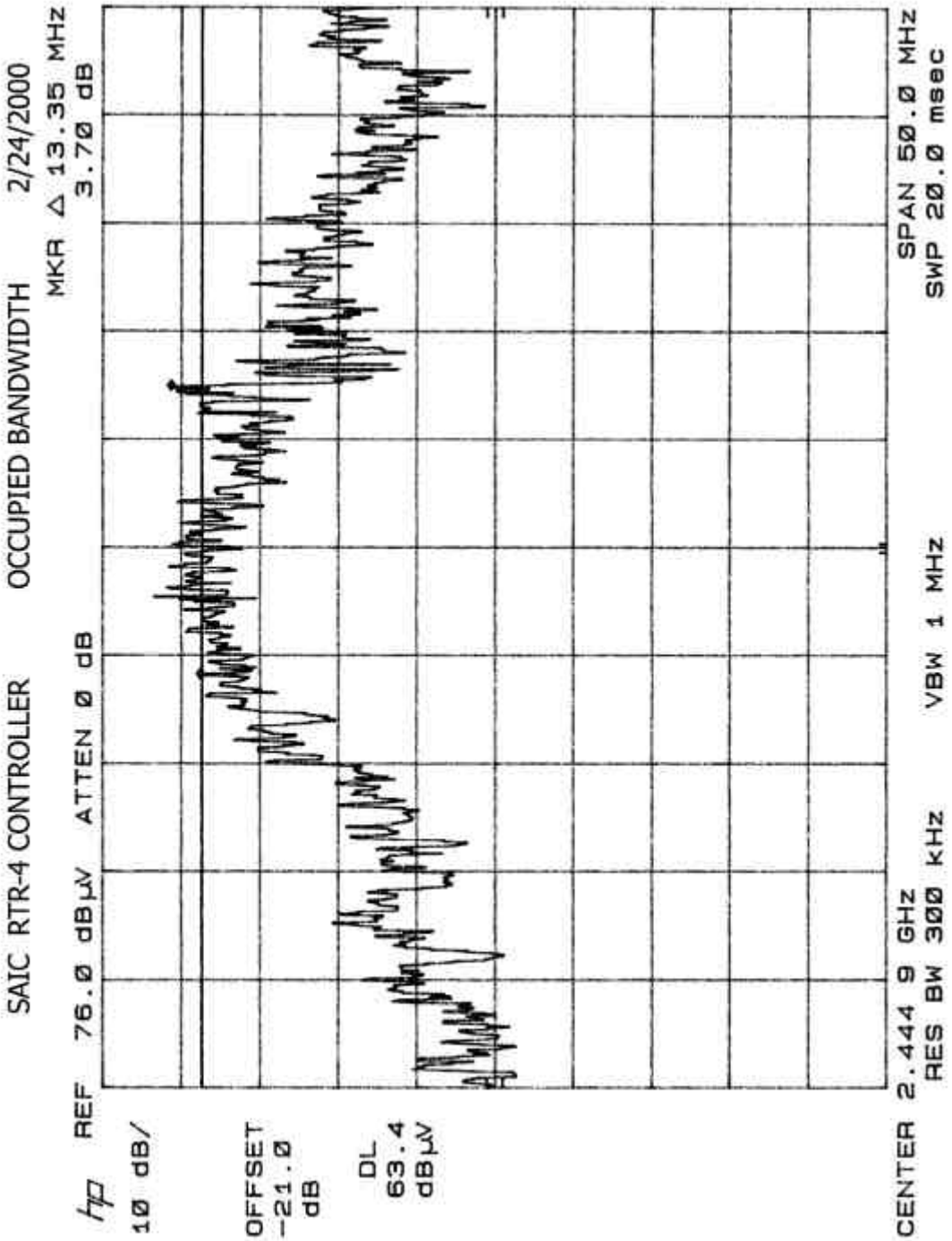
5.4 Occupied Bandwidth Test Results - §15.231




SAIC RTR-4 IMAGER
OCCUPIED BANDWIDTH
2/24/2000
MKR Δ 11.50 MHz
-0.90 dB
REF 83.0 dBµV
ATTEN 0 dB
10 dB/
OFFSET
-14.0
dB
DL
70.4
dBµV
CENTER 2.445 8 GHz
RES BW 30 kHz
VBW 1 MHz
SPAN 50.0 MHz
SWP 150 msec


SAIC RTR-4 IMAGER
OCCUPIED BANDWIDTH
2/24/2000
MKR Δ 10.75 MHz
-0.20 dB
REF 83.0 dBµV
ATTEN 0 dB
10 dB/
OFFSET
-14.0
dB
DL
71.8
dBµV
CENTER 2.445 8 GHz
RES BW 300 kHz
VBW 1 MHz
SPAN 50.0 MHz
SWP 20.0 msec


SAIC RTR-4 CONTROLLER
OCCUPIED BANDWIDTH
2/24/2000
MKR Δ 10.95 MHz
-0.70 dB
REF 76.0 dBµV
ATTEN 0 dB
10 dB/
OFFSET
-21.0
dB
DL
61.1
dBµV
CENTER 2.444 9 GHz
RES BW 30 kHz
VBW 1 MHz
SPAN 50.0 MHz
SWP 150 msec


SAIC RTR-4 CONTROLLER
OCCUPIED BANDWIDTH
2/24/2000
MKR Δ 13.35 MHz
3.70 dB
REF 76.0 dBµV
ATTEN 0 dB
10 dB/
OFFSET
-21.0
dB
DL
63.4
dBµV
CENTER 2.444 9 GHz
RES BW 300 kHz
VBW 1 MHz
SPAN 50.0 MHz
SWP 20.0 msec

APPENDIX A
Conducted & Radiated Emissions Measurement Uncertainties

1. Introduction

ISO Guide 25(1990) and ANSI/NCSL Z540-1(1994) require that all measurements contained in a test report be "traceable". "Traceability" is defined in the *International Vocabulary of Basic and General Terms in Metrology* (ISO: 1993) as: "the property of the result of a measurement... whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons, *all having stated uncertainties*".

The purposes of this Appendix are to "state the *Measurement Uncertainties*" of the conducted emissions and radiated emissions measurements contained in Section 5 of this Test Report, and to provide a practical explanation of the meaning of these measurement uncertainties.

2. Statement Of The Worst-Case Measurement Uncertainties For The Conducted And Radiated Emissions Measurements Contained In This Test Report

Table 1: Worst-Case Expanded Uncertainty "U" of Measurement for a k=2 Coverage Factor

Conducted Emissions Measurement Detection Systems	Applicable Frequency Range	"U" for a k=2 Coverage Factor
HP8568B Spectrum Analyzer with QPA and HP8447F Preamplifier	150 kHz - 30 MHz	+/- 3.0 dB
HP8566B Spectrum Analyzer with QPA and Preselector	9 kHz - 30 MHz	+/- 2.9 dB
Radiated Emissions Measurement Detection Systems	**Applicable Frequency Range**	**"U" for a k=2 Coverage Factor**
HP8568B Spectrum Analyzer with QPA & HP8447F Preamplifier	30 MHz - 200 MHz	+4.0 dB, -4.1 dB
HP8568B Spectrum Analyzer with QPA & HP8447F Preamplifier	200 MHz-1000 MHz	+/- 3.5 dB
HP8566B Spectrum Analyzer with QPA & Preselector	30 MHz - 200 MHz	+3.9 dB, -4.0 dB
HP8566B Spectrum Analyzer with QPA & Preselector	200 MHz-1000 MHz	+/- 3.4 dB
HP8566B Spectrum Analyzer with QPA & HP 8449A Preamplifier	1 GHz - 18 GHz	+2.5 dB, -2.6 dB
HP8566B Spectrum Analyzer with QPA & HP8449A Preamplifier	18 GHz - 40 GHz	+/- 3.4 dB

NOTES:
1. Applies to 3 and 10 meter measurement distances
2. Applies to all valid combinations of Transducers (i.e. LISNs, Line Voltage Probes, and Antennas, as appropriate)
3. Excludes the Repeatability of the EUT

3. Practical Explanation Of The Meaning Of The Conducted And Radiated Emissions Measurement Uncertainties

In general, a "Statement of Measurement Uncertainty" means that with a certain (specified) confidence level, the "true" value of a measurand will be between a (stated) upper bound and a (stated) lower bound.

In the specific case of EMC Measurements in this test report, the measurement uncertainties of the conducted emissions measurements and the radiated emissions measurements have been calculated in accordance with the method detailed in the following documents:

- *ISO Guide to the Expression of Uncertainty in Measurement* (ISO, 1993)
- NIS 81:1994, *The Treatment of Uncertainty in EMC Measurements* (NAMAS, 1994)
- NIST Technical Note 1297(1994), *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results* (NIST, 1994)

The calculation method used in these documents requires that the stated uncertainty of the measurements be expressed as *an "expanded uncertainty", U, with a k=2 coverage factor*. The practical interpretation of this method of expressing measurement uncertainty is shown in the following example:

EXAMPLE:

Assume that at 39.51 MHz, the (measured) radiated emissions level was equal to +26.5 dBμV/m, and that the +/- 2σ (i.e. 95% confidence level) measurement uncertainty was +/- 3.4 dB.

In the example above, the phrase "k = 2 Coverage Factor" simply means that the measurement uncertainty is stated to cover +/-2 standard deviations (i.e. a 95% confidence interval) about the measurand. The measurand is the radiated emissions measurement of +26.5 dBμV/m at 39.51 MHz, and the 95% bounds for the uncertainty are –3.4 dB to + 3.4 dB. One can thus be 95% confident that the "true" value of the radiated emissions measurement is between +23.1 dBμV/m and +29.5 dBμV/m. *In effect, this means that in the above example there is only a 2.5% chance that the "true" radiated emissions value exceeds +29.5 dBmV/m.*

APPENDIX B
Nemko EESI, Inc.'s Test Equipment & Facilities Calibration Program

Nemko EESI, Inc. operates a comprehensive Periodic Calibration Program in order to ensure the validity of all test data. Nemko EESI's Periodic Calibration Program is fully compliant to the requirements of NVLAP Policy Guide PG-1-1988, ANSI/NCSL Z540-1 (1994), ISO 10012-1 (1993-05-01), ISO Guide 25 (1990), ISO-9000 and EN 45001. Nemko EESI, Inc.'s calibration program therefore meets or exceed the US national commercial and military requirements [N.B. ANSI/NCSL Z540-1 (1994) replaces MIL-STD-45662A].

Specifically, all of Nemko EESI's *primary reference standard devices* (e.g. vector voltmeters, multimeters, attenuators and terminations, RF power meters and their detector heads, oscilloscope mainframes and plug-ins, spectrum analyzers, RF preselectors, quasi-peak adapters, interference analyzers, impulse generators, signal generators and pulse/function generators, field-strength meters and their detector heads, etc.) and certain *secondary standard devices* (e.g. RF Preamplifiers used in CISPR 11/22 and FCC Part 15/18 tests) are periodically recalibrated by:

- A Nemko EESI-approved independent (third party) metrology laboratory that uses NIST-traceable standards and that is ISO Guide 25-accredited as a calibration laboratories by NIST; or,
- A Nemko EESI-approved independent (third party) metrology laboratory that uses NIST-traceable standards and that is ISO Guide 25-accredited as a calibration laboratory by another accreditation body (such as A2LA) that is mutually recognized by NIST; or,
- A manufacturer of Measurement and Test Equipment (M&TE), if the manufacturer uses NIST-traceable standards and is ISO Guide 25-accredited as calibration laboratory either by NIST or by another accreditation body (such as A2LA) that is mutually recognized by NIST; or
- A manufacturer of M&TE (or by a Nemko EESI-approved independent third party metrology laboratory) that is not ISO Guide 25-accredited. (In these cases, Nemko EESI conducts an annual audit of the manufacturer or metrology laboratory for the purposes of proving traceabilty to NIST, ensuring that adequate and repeatable calibration procedures are being applied, and verifying conformity with the other requirements of ISO Guide 25).

In all cases, the entity performing the Calibration is required to furnish Nemko EESI with a calibration test report and/or certificate of calibration, and a "calibration sticker" on each item of M&TE that is successfully calibrated.

Calibration intervals are normally one year, except when the manufacture advises a shorter interval (e.g. the HP 8568B Spectrum Analyzer is recalibrated every six months) or if US Government directives or client requirements demand a shorter interval. Items of instrumentation/related equipment which fail during routine use, or which suffer visible mechanical damage (during use or while in transit), are sidelined pending repair and recalibration. (Repairs are carried out either in-house [if minor] or by a Nemko EESI-approved independent [third party] metrology laboratory, or by the manufacturer of the item of M&TE).

Each antenna used for CISPR 11 and CISPR 22 and FCC Part 15 and Part 18 radiated emissions testing (and for testing to the equivalent European Norms) is calibrated annually by either a NIST (or A2LA) ISO Guide 25-Accredited third-party Antenna Calibration Laboratory or by the antenna's OEM if the OEM is NIST or A2LA ISO Guide 25-accredited as an antenna calibration laboratory. The antenna calibrations are performed using the methods specified in Annex G.5 of CISPR 16-1(1993) or ANSI C63.5-1991, including the "Three-Antenna Method". Certain other kinds of antennas (e.g. magnetic-shielded loop antennas) are calibrated annually by either a NIST (or A2LA) ISO Guide 25-accredited third-party antenna calibration laboratory, or by the antenna's OEM if the OEM is NIST or A2LA ISO Guide 25-accredited as an antenna calibration laboratory using the procedures specified in the latest version of SAE ARP-958.

In accordance with FCC and other regulations, Nemko EESI recalibrates its suite of antennas used for radiated emissions tests on an annual basis. These calibrations are performed as a precursor to the FCC-required annual revalidation of the Normalized Site Attenuation properties of Nemko EESI's Open Area Test Site. Nemko EESI, Inc. uses the procedures given in both Subclause 16.6 and Annex G.2 of CISPR 16-1 (1993), and, ANSI C63.4-1992 when performing the normalized site attenuation measurements.