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FCC Certification Test Report
For the
Mine Safety Appliances Company
MSA NightFighter HUD

FCC ID: P9R-10113130

WLL JOB# **11467**
August 11, 2010

Prepared for:

Mine Safety Appliances Company
1000 Cranberry Woods Drive
Cranberry Township, PA 16066-5208

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

ACLASS ACCREDITED TESTING

Testing Certificate AT-1448

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Prepared by:

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Compliance Engineer

Reviewed by:

Steven D. Koster
EMC Operations Manager

Abstract

This report has been prepared on behalf of Mine Safety Appliances Company to support the attached Application for Equipment Authorization. The test report and application are submitted for a Transmitter under Part 15.209 (10/2009) of the FCC Rules and Regulations. This Certification Test Report documents the test configuration and test results for the Mine Safety Appliances Company MSA NightFighter HUD.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

The Mine Safety Appliances Company MSA NightFighter HUD complies with the limits for a Transmitter device under FCC Part 15.209.

Revision History	Description of Change	Date
Rev 0	Initial Release	August 11, 2010

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1 Introduction

1.1 Compliance Statement

The Mine Safety Appliances NightFighter® HUD Transmitter complies with the limits for a Intentional Radiator device under Part 15.209 of the FCC Rules and Regulations.

1.2 Test Scope

Tests for radiated emissions were performed. All measurements were performed according to the 2009 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Mine Safety Appliances, Instrument Division 1000 Cranberry Woods Drive Pittsburgh, PA 16066
Quotation Number:	65533

1.4 Test Dates

Testing was performed on	August 5, 2010.

1.5 Test and Support Personnel

Washington Laboratories, LTD	Steven Dovell
Customer	Greg Imblum

1.6 Abbreviations

A	Ampere
Ac	alternating current
AM	Amplitude Modulation
Amps	Amperes
b/s	bits per second
BW	Bandwidth
CE	Conducted Emission
Cm	centimeter
CW	Continuous Wave
dB	decibel
Dc	direct current
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FM	Frequency Modulation
G	giga - prefix for 10^9 multiplier
Hz	Hertz
IF	Intermediate Frequency
K	kilo - prefix for 10^3 multiplier
M	Mega - prefix for 10^6 multiplier
M	Meter
μ	micro - prefix for 10^{-6} multiplier
NB	Narrowband
LISN	Line Impedance Stabilization Network
RE	Radiated Emissions
RF	Radio Frequency
Rms	root-mean-square
SN	Serial Number
S/A	Spectrum Analyzer
V	Volt

2 Equipment Under Test

2.1 EUT Identification & Description

The Heads-Up Display (HUD) Transmitter is similar in appearance and function to the existing NightFighter HUD Transmitter (P9R-10031511) device. The circuit board in this unit was modified to comply with the Underwriters Laboratory Intrinsic Safety Standard UL-913, 6th edition. The HUD Transmitter is worn by fire-fighters on their Self Contained Breathing Apparatus (SCBA). The transmitter measures the air pressure in the user's air cylinder and transmits digital data to the HUD receiver with a low-power low-frequency (27 KHz) transmitter.

The transmitter contains a pressure sensor and the receiver displays the pressure in the SCBA face piece with an LED bar graph. Four green LED's represents a full tank, three green LED's represents three quarters of a tank, two yellow flashing LED's signify one half of a tank, and one flashing red LED lights at the end of service. A yellow LED is for transmitter and receiver low battery and one orange and one red LED are for future use.

Normally, the NightFighter HUD Transmitter is in a standby mode where the pressure sensor is read every 5 seconds. If no air pressure is detected, the transmitter returns to a low-power standby mode. If a pressure equivalent to 200 psi or greater is detected then the transmitter enters into an active mode where the pressure is read every 2 seconds and the pressure status is then transmitted to the HUD receiver. Normally, the LEDs will stay active for 30 seconds at each quarter cylinder transition. The receiver can be placed in a continuous display mode by pressing and holding the green button on the transmitter for three seconds. The transmitter will automatically return to the low-power standby mode when the air cylinder pressure drops below 200psi for at least one minute.

The data is Manchester encoded and transmitted through a short-range LF link using FSK transmission. The transmitter outputs the encoded digital data in a serial stream from the microcontroller. The frequency-encoded data is filtered and amplified by the antenna. The receiver demodulates and decodes the data and displays the pressure readings on an LED bargraph.

The transmitter transmits one data packet out approximately every two seconds in the active mode. Data packet length is approximately 90 milliseconds. The data rate for encoded data is 1kbps that translates to a decoded data rate of 500 bps.

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Mine Safety Appliances
FCC ID:	P9R-10113130
EUT Name:	NightFighter HUD
Model:	Control Module
FCC Rule Parts:	§15.209
Frequency Range:	26.3 – 27.8 KHz
Occupied Bandwidth:	4.892kHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Integral Magnetic Induction
Interface Cables:	None
Power Source & Voltage:	Battery

2.2 Test Configuration

The Control Module was tested in a stand-alone configuration.

2.3 Testing Algorithm

The Control Module was operated continuously by being placed into its normally operating mode when attached to a full oxygen tank.

Worst case emission levels are provided in the test results data.

2.4 Test Location

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory

2.5 Measurements

2.5.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{div_a{}^2} + \frac{b^2}{div_b{}^2} + \frac{c^2}{div_c{}^2} + ...}$$

Where u_c = standard uncertainty

a, b, c,.. = individual uncertainty elements

$Div_{a,\ b,\ c}$ = the individual uncertainty element divisor based on the probability distribution

Divisor = 1.732 for rectangular distribution

Divisor = 2 for normal distribution

Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

Where U = expanded uncertainty

k = coverage factor

k ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to

determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 2 below.

Table 2: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	4.55 dB

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3 Test Equipment

Table 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment List

Test Name:	**Radiated Emissions**	Test Date:	**08/05/2010**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
69	HP - 85650A	ADAPTER QP	7/1/2011
73	HP - 8568B	ANALYZER SPECTRUM	7/1/2011
71	HP - 85685A	PRESELECTOR RF	7/1/2011
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	12/29/2010
31	EMCO - 6502	ANTENNA ACTIVE LOOP	3/8/2012
618	HP - 8563A	ANALYZER SPECTRUM	6/4/2011

4 Test Results

4.1 Occupied Bandwidth: (FCC Part §2.1049)

Occupied bandwidth was performed by setting the EUT near the loop antenna to allow for sufficient pickup of the signal.

At full modulation, the occupied bandwidth (20dB) was measured at 4.982 kHz as shown in the following plot:

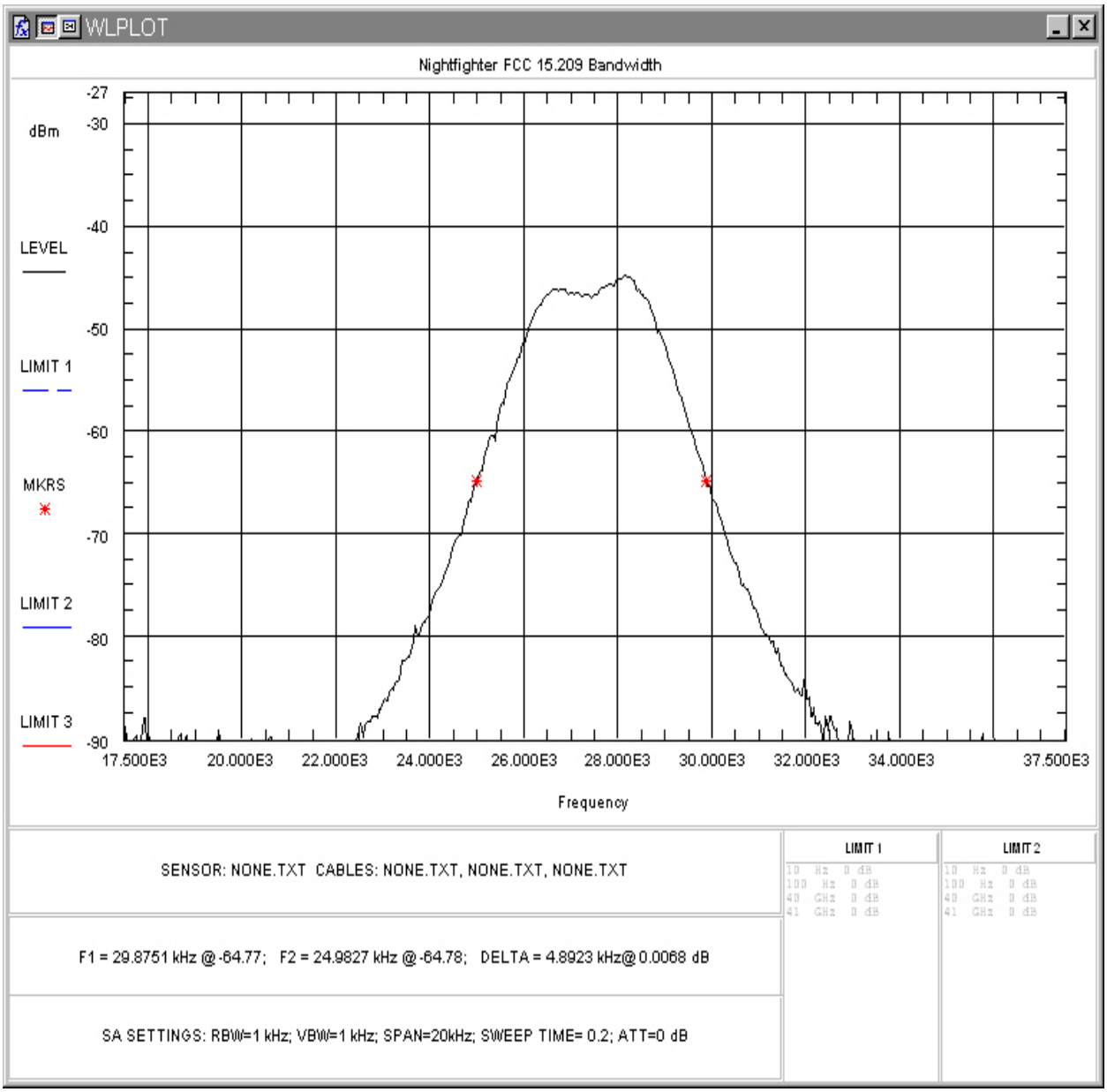

Figure 1. Occupied Bandwidth

4.2 Radiated Spurious Emissions: (FCC Part §15.209)

Transmitters operating under §15.209 must comply with the radiated emissions listed in the following table:

Table 4. Radiated Emissions Limits

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

4.2.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. Both the horizontal and vertical field components were measured.

The EUT was scanned from 10k to 1GHz. The limit has been interpolated to 3m using the 40dB per decade roll-off for frequencies between 10k to 30MHz.

Table 5. Radiated Emissions Test Data

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
0.0281	V	270.00	1.00	61.80	13.3	5673.8	854092.5	-43.6
0.0561	V	270.00	1.00	46.10	10.9	705.8	427807.5	-55.7
0.0835	V	270.00	1.00	42.00	10.6	424.8	287425.1	-56.6
0.1220	V	270.00	1.00	40.00	10.5	333.9	196734.2	-55.4
0.28	V	270.00	1.00	34.80	10.3	180.3	86021.5	-53.6
0.26	V	270.00	1.00	35.40	10.3	193.6	93750.0	-53.7
164.00	V	345.00	1.00	8.50	14.3	13.8	150.0	-20.7
417.43	V	0.00	1.00	8.50	19.4	24.8	200.0	-18.1
48.00	H	180.00	4.00	8.20	8.1	6.5	100.0	-23.7
76.42	H	0.00	4.00	17.00	10.5	23.8	100.0	-12.5
110.00	H	0.00	4.00	4.70	15.0	9.7	150.0	-23.8
120.71	H	270.00	4.00	10.20	15.8	20.0	150.0	-17.5
161.68	H	265.00	2.00	15.50	14.5	31.6	150.0	-13.5
448.00	H	270.00	1.82	14.20	20.9	56.9	200.0	-10.9

Example @ 28.1 kHz

Limit = 10^(((40*LOG(300/3))+(20*log(2400/f)))/20)

854092.5 uV/m

