FCC & ISED CANADA CERTIFICATION

TEST REPORT

for the

FREDERICK ENERGY PRODUCTS, LLC

FCC ID: QUI-FS-SILENCER

IC ID: 11625A-FSSILENCER

WLL REPORT# 16862-01 REV 2

Prepared for:

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Testing Certificate AT-1448

FCC & ISED Canada Certification

Test Report

for the

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FS Cab Silencer

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February 20, 2021

WLL Report# 16862-01 Rev 2

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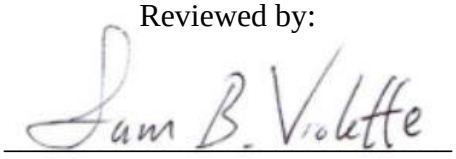

Samuel B. Violette

Vice President

Abstract

This report has been prepared on behalf of Frederick Energy Products, LLC to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 15.209 (10/2014) of the FCC Rules and Regulations and RSS GEN Issue 5 (3/2019) of Innovation, Science and Economic Development (ISED) Canada. This Certification Test Report documents the test configuration and test results for the Frederick Energy Products, LLC FS Cab Silencer.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 4840 Winchester Boulevard, Frederick, MD 21703. 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.

Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory. (ISED Canada number 3035A).

The Frederick Energy Products, LLC FS Cab Silencer complies with the limits for an intentional radiator device under FCC Part 15.209 (10/2014) and ISED Canada RSS GEN Issue 5 (3/2019).

Revision History	Description of Change	Date
Rev 0	Initial Release	February 20, 2021
Rev 1	ACB Comments	6/24/2021
Rev 2	ACB Comments # ACTB026961 v2	7/15/2021
Rev 3	ACB Comment/Remove Modules	7/15/2021

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1 Introduction

1.1 Compliance Statement

The Frederick Energy Products, LLC FS Cab Silencer complies with the limits for an intentional radiator under FCC Part 15.209 (10/2014) and (ISED) Canada RSS GEN Issue 5 (3/2019).

1.2 Test Scope

Tests for radiated and conducted emissions were performed. All measurements were performed in accordance with the 2014 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

Test Specification	Specific Description	Result	Modifications (Y/N)
CFR47 Part 15.209, RSS Gen section 7.2.5	Class B Radiated Emissions	Pass	N
RSS Gen Section 6	Receiver Spurious Emissions	Pass (N/A) *TX Only*	N

1.3 Contract Information

Customer:	Frederick Energy Products, LLC
Purchase Order Number:	9119
Quotation Number:	72358

1.4 Test and Support Personnel

Washington Laboratories, LTD	Samuel Violette
Customer Representative	Andrew Nichols

2 Equipment Under Test

2.1 EUT Identification & Description

Table 1: Device Summary

Manufacturer:	Frederick Energy Products, LLC
FCC ID:	QUI-FS-SILENCER
ISED ID:	11625A-FSSILENCER
EUT Model:	FS Cab Silencer
Serial Number of Unit Tested	Not listed on EUT
FCC Rule Parts:	§15.209
ISED Rule Parts:	RSS GEN Issue 5
IC Emission Designator	8K3NON
Frequency Range:	73 kHz
99% Occupied Bandwidth:	8.302 kHz
Keying:	Automatic
Type of Information:	CW (illumination)
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Integral Magnetic Induction
Interface Cables:	Power, warning module cable
Power Source & Voltage:	Battery (12 VDC)
Highest TX emission	73kHz: 27829.2 uV/m @ 3m
EUT Test Firmware/Software	FEPL Proprietary Test Mode, REV A
Test Dates:	2/20/2021 to 6/22/2021

The Frederick Energy Products, LLC FS Cab Silencer is is used with the Frederick Energy “Hit Not” system.

The Frederick Energy Products, LLC FS Cab Silencer transmits an adjustable magnetic field to silence PADs.

A useful video of the system can be found here: https://hitnot.com/#facility

2.2 Test Configuration

The FS Cab Silencer, Equipment Under Test (EUT), was operated from a DC supply to simulate vehicle power.

The EUT was set up as outlined in Figure 1. The EUT was comprised of the following equipment. (All Modules, PCBs, etc. listed were considered as part of the EUT, as tested.)

Figure 1: Test Configuration

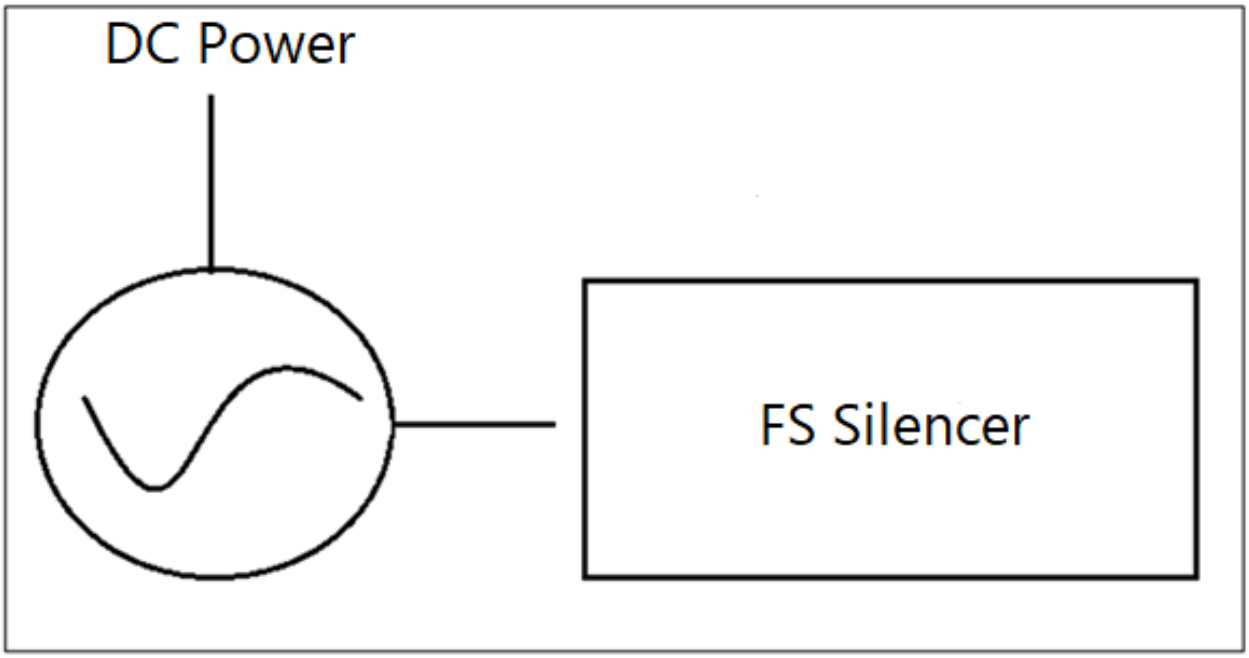

Table 2: System Configuration List

Name / Description	Manufacturer	Model Number	Serial Number	Revision
FS Cab Silencer	Frederick Energy LLC	R1309890	N/A	N/A

2.3 Support Equipment

Name / Description	Manufacturer	Model Number
DC Power Supply	EVENTEK	KPS3010D

2.4 Interface Cables

Table 3: Cable Configuration

Port Identification	Connector Type	Cable Length	Shielded (Y/N)	Termination Point
DC Mains	2-conductor	1m	N	DC Supply

2.5 Testing Algorithm

The EUT operates continuously when power is applied.

Worst case emission levels are provided in the test results data. PAD support unit was brought within range of the generator to activate receive warning alarms.

2.6 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Frederick, MD. 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 ISED Canada OATS number for Washington Laboratories, Ltd. is 3035A. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

2.7 Measurements

2.7.1 References

ANSI C63.2 (Jan-2016) Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 (Jan 2014) 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

ANSI C63.10 (Jun 2013) American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

ANSI C63.26 (Dec 2015) American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

2.8 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2002) 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 uc = standard uncertainty
a, b, c,.. = individual uncertainty elements
Diva, 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)
uc = 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 4 below.

Table 4: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	±2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	±4.55 dB

3 Test Equipment

Table 5 shows a list of the test equipment used for measurements along with the calibration information.

Table 5: Test Equipment List

Test Name:	**Radiated Emissions**	Test Date:	**1/10/2021**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00382	SUNOL SCIENCES CORPORATION JB1	ANTENNA BICONLOG	12/31/2021
00031	EMCO 6502	ANTENNA ACTIVE LOOP	3/17/2021
00823	AGILENT N9010A	EXA SPECTRUM ANALYZER	5/7/2021
00558	HP 8447D	AMPLIFIER	5/18/2021

4 Test Results

4.1 Radiated Spurious Emissions: FCC §15.209 & ISED RSS GEN Table 6

Radiated emissions from the EUT must comply with the field strength limits as specified in FCC Part 15.225 and 15.209 and IC RSS 210 and RSS GEN. The limits for the radiated emissions are as shown in the following table.

Table 6: Radiated Spurious Emissions Limits

Frequency (MHz)	Field Strength (μV/m)	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

4.1.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter Open Area Test Site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable.

For frequencies between 10 kHz and 30 MHz, a loop antenna was mounted of a tripod at height of 1 m. The Loop antenna was rotated about its vertical and horizontal axis to determine the highest emissions.

For frequencies above 30MHz the 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, to the 10th harmonic of the fundamental transmitter, from 10kHz to 3GHz (to include the receiver data). The limit at 300m has been interpolated to 3m.

The EUT was examined in three orthogonal planes, and the orthogonal that demonstrated the highest emission was reported.

Also, the alternative functions of the EUT, that potentially result in a slightly altered 73kHz magnetic field, have been investigated. The worst case emission are reported.

All Fundamental and Harmonics were tested for peak emissions and compared to the Average limits as this is a CW signal. As the CW complies with the average limits it also complies with the peak limits of part 15.35. All other spurious signals were tested using average or quasi-peak detectors as specified.

In accordance with FCC part15.209 (d) emissions in the bands 9-90 kHz and 110-490 kHz are performed using an average detector. All other readings below 1000MHz were taken with a quasi-peak detector.

Resolution bandwidths used for frequencies measured between:

- 9 kHz – 150kHz, RBW = 200Hz
- 150kHz – 30MHz, RBW = 9kHz
- 30MHz – 1GHz, RBW = 120kHz

And, for frequencies measured above 1GHz:

- RBW = 1MHz

4.1.2 Test Results

The EUT complies with the radiated emission requirements of §15.209 and RSS-210. The following tables provide the test data.

Also note that the limits in CFR 47, Part 15 Subpart C, para. 15.209(a) are the same as RSS-GEN. The measurements were made in terms of magnetic FS that were then converted to electric FS levels, as reported in the test data tables below.

The limit at 300m has been interpolated to 3m.

Test results reflect worst case emissions.

See page 17 for further data.

Table 7: Radiated Emissions below 30MHz

Freq (kHz)	Orient	SA Level (dBuV)	Corr. Factor	E-Field (dBuV/m)	E-Field (uV/m)	Limit (dBuV/m)	Limit (uV/m)	Margin (dB)
73.0	X	72.8	10.8	83.6	15066.1	110.3	328767.12	-26.8
146.0	X	57.3	10.5	67.8	2453.9	104.3	164383.56	-36.5
219.0	X	57.1	10.5	67.6	2388.4	100.8	109589.04	-33.2
292.0	X	52.4	10.5	62.9	1395.1	98.3	82191.78	-35.4
365.0	X	48.0	10.5	58.5	837.0	96.4	65753.42	-37.9
438.0	X	50.4	10.5	60.9	1106.5	94.8	54794.52	-33.9
73.0	Y	70.6	10.8	81.4	11720.6	110.3	328767.12	-29.0
146.0	Y	61.6	10.5	72.1	4006.8	104.3	164383.56	-32.3
219.0	Y	45.4	10.5	55.9	626.5	100.8	109589.04	-44.9
292.0	Y	45.0	10.5	55.5	596.9	98.3	82191.78	-42.8
365.0	Y	40.3	10.5	50.8	347.3	96.4	65753.42	-45.5
438.0	Y	37.0	10.5	47.5	237.7	94.8	54794.52	-47.3
73.0	Z	61.0	10.8	71.8	3889.1	110.3	328767.1	-38.5
146.0	Z	53.5	10.5	64.0	1593.1	104.3	164383.6	-40.3
219.0	Z	51.8	10.5	62.3	1310.5	100.8	109589.0	-38.4
292.0	Z	46.5	10.5	57.0	706.4	98.3	82191.8	-41.3
365.0	Z	41.2	10.5	51.7	383.0	96.4	65753.4	-44.7
438.0	Z	40.3	10.5	50.8	344.7	94.8	54794.5	-44.0

***** The above measurements were taken at 3m

4.1.3 Test Data for Canada

The EUT complies with the requirements of RSS 210 (RSS-GEN limits) as shown in the data tables.

For measurement data shown in this section, the EUT was evaluated to the 10th harmonic of the fundamental.

** Note –

The RSS-Gen field strength limit for the 73 kHz transmitter is .087 uA/m at 300m.

The highest amplitude, of the EUT fundamental, measured 72.8 dBuV at 3m.

RSS-Gen Notes for the table below:

- Limit interpolation (correction factor) is defined as 40*LOG(300/3) = 80 dB
- E-to H-field conversion is 0*LOG(120pi) = 20 *LOG(377) = 51.5 dBΩ
- (reference: ANSI C63.10, 7.7.2).

Table 8: 73kHz Test Data for ISED Canada

Frequency (kHz)	EUT Polarity	SA Level (dBuV)	Antenna Factor (dB)	Distance Corr.	H-Field Corr.	Corr. Level (dBuA/m)	300m Limit (uA/m)	Limit Conversion (dBuA/m)	Margin (dB)	Detector
73.0	X	72.80	11.0	80.0	51.5	-47.7	0.087	-21.2	-26.5	AVG
73.0	Y	70.60	11.0	80.0	51.5	-49.9	0.087	-21.2	-28.7	AVG
73.0	Z	61.00	11.0	80.0	51.5	-59.5	0.087	-21.2	-38.3	AVG

Table 9: Radiated Emissions above 30MHz

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)	Detector Type
56.00	V	45.0	1.8	56.0	-17.8	81.1	100.0	-1.8	QP
66.70	V	45.0	1.8	51.6	-17.0	53.9	100.0	-5.4	QP
119.00	V	45.0	1.8	28.9	-11.1	7.8	150.0	-25.7	QP
140.00	V	45.0	1.8	35.0	-11.8	14.5	150.0	-20.3	QP
203.16	V	45.0	1.8	42.3	-12.3	31.3	150.0	-13.6	QP
280.00	H	180.0	1.8	30.3	-10.5	9.8	200.0	-26.2	QP
56.00	H	45.0	1.8	36.8	-17.8	8.9	100.0	-21.0	QP
66.70	H	45.0	1.8	34.0	-17.0	7.1	100.0	-22.9	QP
119.00	H	45.0	1.8	33.1	-11.1	12.6	150.0	-21.5	QP
140.00	H	45.0	1.8	39.0	-11.8	22.9	150.0	-16.3	QP
203.16	H	180.0	1.8	53.5	-12.3	114.3	150.0	-2.4	QP
262.00	H	180.0	1.8	37.5	-11.9	19.0	200.0	-20.4	QP
280.00	H	180.0	1.8	36.0	-10.5	19.0	200.0	-20.5	QP

4.2 Conducted Emissions (AC Power Line) FCC §15.207 & ISED RSS GEN

The EUT was DC Powered.

4.3 Occupied Bandwidth: (FCC Part §2.1049, RSS –Gen)

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

The transmit signal is a 73 kHz non-modulated CW signal, the OBW plot is shown below.