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FCC/Industry Canada Certification Test Report

For the

Frederick Energy Products LLC

HN-MFG-XL Magnetic Field Generator

FCC ID: QUI-HN-MFG-XL
IC: 11625A-HNMFGXL

WLL JOB# **13631-01 Rev 2**

September 29, 2014

Re-issued June 16, 2015

Prepared for:

Frederick Energy Products LLC
1769 Jeff Road
Huntsville, AL 35806

Prepared By:

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

ACLASS ACCREDITED TESTING

Testing Certificate AT-1448

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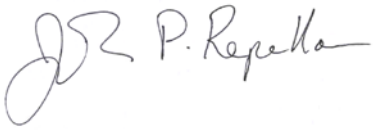
Prepared by:

Steven Dovell
Compliance Engineer

Reviewed by:



John P. Repella
EMC & Wireless Lab Manager

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 a Transmitter under Part 15.209 (10/2013) of the FCC Rules and Regulations and Industry Canada RSS-210 issue 8 (12/2010) and RSS-Gen issue 3 (12/2010). This Certification Test Report documents the test configuration and test results for the Frederick Energy Products LLC Magnetic Field Generator.

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 Frederick Energy Products LLC HN-MFG-XL Magnetic Field Generator complies with the limits for a Transmitter device under FCC Part 15.209 and RSS210 issue 8.

Revision History	Description of Change	Date
Rev 0	Initial Release	September 29, 2014
Rev 1	Updated Tables 8, 9 &10 for distance	March 13, 2015
Rev 2	Updated Table 8 to address maximum power output at fundamental and associated harmonics.	June 16, 2015

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1 Introduction

1.1 Compliance Statement

The Frederick Energy Products LLC HN-MFG-XL Magnetic Field Generator complies with the limits for an Intentional Radiator device under Part 15.209 of the FCC Rules and Regulations and Industry Canada RSS-210 issue 8.

1.2 Test Scope

Tests for radiated emissions were performed. All measurements were performed according to the 2003 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:	Frederick Energy Products LLC 1769 Jeff Drive, Huntsville, AL, 35806
Quotation Number:	68183A

1.4 Test Dates

Testing was performed on the following date(s):	9/24/2014

1.5 Test and Support Personnel

Washington Laboratories, LTD	Steven Dovell
Customer Representative	Ed Richardson

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 Frederick Energy Product, LLC HN-MFG-XL Magnetic Field Generator produces a 73 kHz proximity field (CW signal). When a Personal Alarm Device (PAD) enters this field it causes the PAD unit to visually and audibly alarm. In addition the PAD unit sends data back to the HN-MFG-XL Magnetic Field Generator receiver on 916 MHz that causes the generator to visibly and audibly alarm. The HN-MFG-XL Magnetic Field Generator is comprised of the main unit and a warning module that contains a visual and audible alarm.

This device is used with the generator mounted on a vehicle while the PAD units are worn by personnel to warn both the equipment operators and people in the proximity of this equipment of possibly dangerous conditions.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Frederick Energy Products LLC
FCC ID:	QUI-HN-MFG-XL
IC:	11625A-HNMFGXL
EUT Name:	HN-MFG-XL Magnetic Field Generator
Model:	HN-MFG-XL
FCC Rule Parts:	15.209
IC Rule Part	RSS210 issue 8 (RSS-Gen Issue 3)
IC Emission Designator	NON
Frequency Range:	73kHz
Occupied Bandwidth:	N/A CW non modulated signal
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 (24 VDC)
Highest TX emission	73kHz , -1.1dB Margin
Highest RX emission	35MHz, -8.6dB Margin

2.2 Test Configuration

The Frederick Energy Products LLC HN-MFG-XL Magnetic Field Generator, Equipment Under Test (EUT), was operated from 24VDC via a Lab AC/DC power supply.

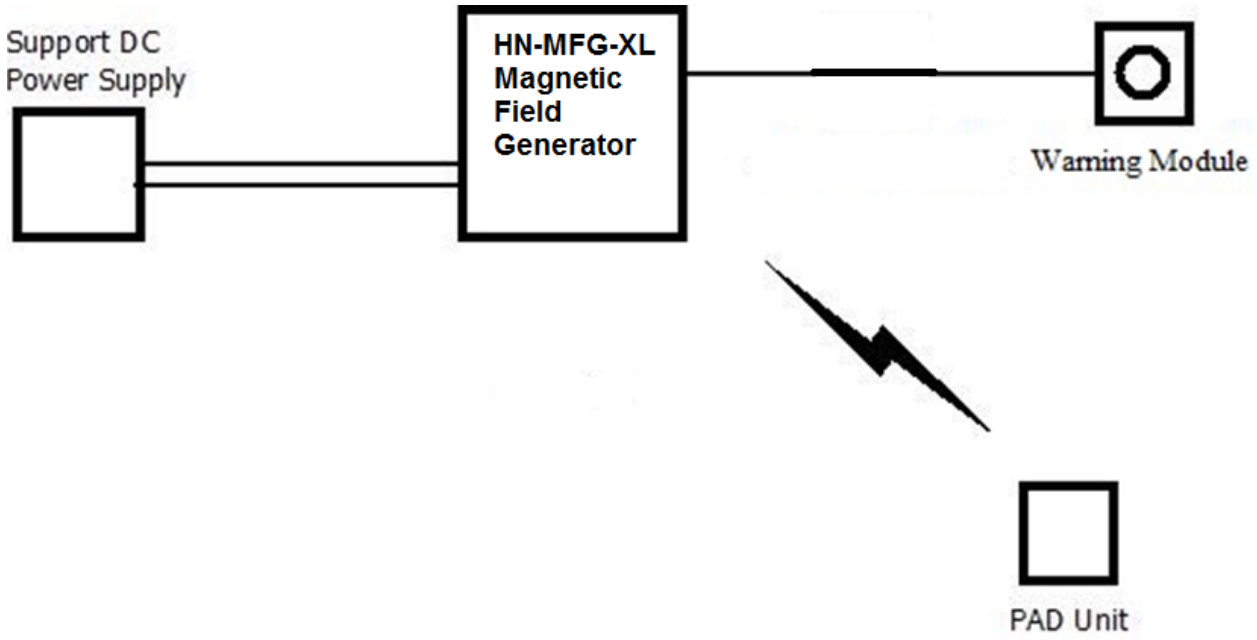

Figure 1: Test Configuration

2.3 Equipment Configuration

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.)

Table 2: Equipment Configuration

Name / Description	Manufacturer	Model	Serial Number	Revision
Magnetic Field Generator	Frederick Energy Products	HN-MFG-XL	XL00118	A
(1) Warning Modules	Frederick Energy Products	HN-WM-LS	WMS03553	--

2.4 Support Equipment

The following support equipment was used during testing:

Table 3: Support Equipment

Item	Model/Part Number	Serial Number
PAD	HN-PAD	PD01163
Power Supply (Primary)	1337DC Power Supply	N/A

2.5 Interface Cables

Table 4: Interface Cables

Port Identification	Connector Type	Cable Length	Shielded (Y/N)	Termination Point
24Vdc input	2 wire to 4 Pin Circular	>1 m	N	Power source to EUT
Warning Module	4 wire circular	>1m	N	Warning Module 1 to Warning Module 2

2.6 EUT Modifications

No modifications were performed in order to meet the test requirements.

2.7 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.

2.8 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.

2.9 Measurements

2.9.1 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

2.10 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2012) 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

$k \leq 2$ 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 5 below.

Table 5: 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

.

3 Test Equipment

Table 6 shows a list of the test equipment used for measurements along with the calibration information.

Table 6: Test Equipment List

Test Name: **Radiated Emissions**		Test Date: **09/24/2014**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
68	HP - 85650A	ADAPTER QP	1/2/2015
72	HP - 8568B	ANALYZER SPECTRUM	1/2/2015
70	HP - 85685A	PRESELECTOR RF W/OPT 8ZE	1/2/2015
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	12/26/2014
31	EMCO - 6502	ANTENNA ACTIVE LOOP	3/18/2016
823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	12/6/2014
4	ARA - DRG-118/A	ANTENNA DRG 1-18GHZ	2/20/2015
66	B&Z - BZ-01002650-401545-282525	PRE-AMPLIFIER RF. 1-26.5GHZ	10/2/2014
528	AGILENT/E4446A	PSA SPECTRUM ANALYZER	4/23/2016
276	BPA-1000	RF PRE-AMP 50kHz-1GHz	8/26/2015

4 Test Results

4.1 Occupied Bandwidth: (FCC Part §2.1049, RSS –Gen sect 4.6.1)

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; therefore there is no measurable bandwidth.

4.2 Radiated Spurious Emissions: (FCC Part §15.209, RSS-Gen Table 6)

Transmitters operating under §15.209 & Industry Canada RSS 210 (RSS-GEN) must comply with the radiated emissions listed in the following table:

Table 7: 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 30-meter open field 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.

Measurements of frequencies above 30MHz were made at a distance of 3m.
The EUT was scanned from 10k to 3GHz (in order to include the receiver data).
The limit at 300m has been interpolated to 30m.

The roll-off was determined as specified in FCC part 15.31 (f)(2) two measurements were made at two distances, 3m and 30m.
The level of the fundamental frequency at 3m was measured as 112.0 dBuV/m

The level of the fundamental frequency at 30m was measured as 64.0 dBuV/m

The difference between the two readings is 48.0dB therefore the roll-off is 48.0dB/decade.

This offset was added to the 300m limit to adjust the limit to 30m:

Example @ 73 kHz:

300m limit = 2400/73 = 32.8767uV/m = 20*Log (32.8767) = 30.3377dBuV/m

30m limit = 30.3377dBuV/m +48.0dB = 78.3377dBuV/m = 10^ (78.3377/20) = 8258.257 uV/m

The EUT was examined in three orthogonals and the orthogonal the demonstrated the highest emission was 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

Table 8: Radiated Emissions Test Data < 30MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level @ 30m (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
0.073	X	90.0	1.0	50.4	26.8	7241.1	8258.3	-1.1	Peak
0.073	Y	180.0	1.0	47.3	27.1	5236.7	8258.3	-4.0	
0.073	Z	270.0	1.0	45.7	27.1	4355.7	8258.3	-5.6	
0.146	X	180.00	1.00	38.50	10.8	291.5	4129.1	-23.0	Peak
0.146	Y	95.00	1.00	34.32	10.8	180.2	4129.1	-27.2	
0.146	Z	0.00	1.00	32.27	10.8	142.3	4129.1	-29.3	
0.219	X	275.0	1.0	41.6	24.3	1963.0	2752.8	-2.9	
0.219	Y	250.0	1.0	42.5	24.3	2177.3	2752.8	-2.0	Peak
0.219	Z	250.0	1.0	38.4	24.3	1358.1	2752.8	-6.1	
0.292	X	350.00	1.00	46.90	10.7	757.5	2064.6	-8.7	Peak
0.292	Y	15.00	1.00	46.00	10.7	682.9	2064.6	-9.6	
0.292	Z	180.00	1.00	43.67	10.7	522.2	2064.6	-11.9	
0.090	X	180.00	1.00	36.20	11.2	235.7	6698.4	-29.1	Restricted Bands
0.090	Y	45.00	1.00	39.37	11.2	339.5	6698.4	-25.9	
0.090	Z	0.00	1.00	37.90	11.2	286.7	6698.4	-27.4	
0.110	X	180.00	1.00	34.45	10.8	183.9	5480.5	-29.5	
0.110	Y	45.00	1.00	42.70	10.8	475.5	5480.5	-21.2	
0.110	Z	180.00	1.00	34.12	10.8	177.1	5480.5	-29.8	

No other harmonic or spurious emissions were detectable below 30MHz

Note: Since the peak readings are below the applicable 15.209 average limits and the transmit occupied bandwidth is non-existent the peak measurements do not exceed the part 15.35 limit (average limit plus 20dB). Therefore the unit was not tested using an average detector in these (*) ranges and is assumed to comply with the peak and average requirements.

Table 9: Radiated Emissions Test Data > 30MHz (TX and RCV)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level @ 3m (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
35.00	V	45.00	1.00	13.50	17.9	37.3	100.0	-8.6	Peak
57.21	V	180.00	1.00	16.10	7.9	15.8	100.0	-16.0	Peak
71.98	V	180.00	1.00	18.30	9.3	23.9	100.0	-12.4	Peak
147.28	V	90.00	1.00	7.80	14.1	12.5	150.0	-21.6	Peak
181.92	V	250.00	1.00	10.50	13.2	15.3	150.0	-19.8	Peak
217.55	V	90.00	1.00	11.20	13.0	16.2	200.0	-21.8	Peak
238.39	V	5.00	1.00	9.30	14.0	14.6	200.0	-22.7	Peak
34.78	H	230.00	4.00	2.50	18.1	10.7	100.0	-19.4	Peak
39.55	H	90.00	4.00	8.60	14.7	14.7	100.0	-16.7	Peak
56.79	H	300.00	4.00	16.10	7.8	15.7	100.0	-16.1	Peak
72.46	H	270.00	4.00	9.20	9.2	8.4	100.0	-21.6	Peak
114.32	H	350.00	4.00	5.60	14.7	10.4	150.0	-23.2	Peak
125.00	H	125.00	4.00	10.40	15.5	19.7	150.0	-17.6	Peak
181.20	H	180.00	4.00	12.10	13.2	18.4	150.0	-18.2	Peak
220.00	H	180.00	2.89	6.10	13.1	9.1	200.0	-26.8	Peak

4.3 Receiver Radiated Emissions (RSS-210 sect 2.5, RSS-GEN sect 6.1)

4.3.1 Requirements

Test Arrangement: Table Top

Compliance Standard: RSS-Gen sect 6.1

RSS-Gen Compliance Limits for Receivers	
Frequency	**Limits**
30-88 MHz	100 µV/m
88-216 MHz	150 µV/m
216-960 MHz	200 µV/m
>960MHz	500 µV/m

4.3.2 Test Procedure

The requirements of RSS-GEN call for the EUT to be placed on an 80 cm high 1 X 1.5 meters non-conductive 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. Bi-conical and log periodic broadband 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. The output of the antenna was connected to the input of the spectrum analyzer and the emissions in the frequency range of 30 MHz to 3 GHz were measured. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The output from the antenna was connected, via a preamplifier, to the input of the spectrum analyzer. The detector function was set to quasi-peak, peak, or average as appropriate. The measurement bandwidth of the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth.

All measurements above 1GHz were made at a distance of 3m with a Resolution Bandwidth of 1MHz and a Video bandwidth of 10Hz. Average readings were taken in a linear mode with zero-span.

4.3.3 Test Data

The EUT complies with the requirements of RSS 210 (RSS-GEN limits) as shown in Table 10.

4.3.4 Radiated Data Reduction and Reporting

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limits, it is necessary to account for various calibration factors that are supplied with the antennas and other measurement accessories. These factors are included into the antenna factor (AF) column of the table and in the cable factor (CF) column of the table. The AF (in dB/m) and the CF (in dB) is algebraically added to the raw Spectrum Analyzer Voltage in dBµV to obtain the Radiated Electric Field in dBµV/m. This logarithm amplitude is converted to linear amplitude, and then compared to the Industry Canada limit.

Example:

Spectrum Analyzer Voltage: VdBµV

Antenna Correction Factor: AFdB/m

Cable Correction Factor: CFdB

Electric Field: EdBV/m = V dBµV + AFdB/m + CFdB

To convert to linear units of measure: EdBV/m/20 Inv log

Table 10: Receiver Radiated Emissions Test Data > 30MHz (TX and RCV)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level @ 3m (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
35.00	V	45.00	1.00	13.50	17.9	37.3	100.0	-8.6	Peak
57.21	V	180.00	1.00	16.10	7.9	15.8	100.0	-16.0	Peak
71.98	V	180.00	1.00	18.30	9.3	23.9	100.0	-12.4	Peak
147.28	V	90.00	1.00	7.80	14.1	12.5	150.0	-21.6	Peak
181.92	V	250.00	1.00	10.50	13.2	15.3	150.0	-19.8	Peak
217.55	V	90.00	1.00	11.20	13.0	16.2	200.0	-21.8	Peak
238.39	V	5.00	1.00	9.30	14.0	14.6	200.0	-22.7	Peak
34.78	H	230.00	4.00	2.50	18.1	10.7	100.0	-19.4	Peak
39.55	H	90.00	4.00	8.60	14.7	14.7	100.0	-16.7	Peak
56.79	H	300.00	4.00	16.10	7.8	15.7	100.0	-16.1	Peak
72.46	H	270.00	4.00	9.20	9.2	8.4	100.0	-21.6	Peak
114.32	H	350.00	4.00	5.60	14.7	10.4	150.0	-23.2	Peak
125.00	H	125.00	4.00	10.40	15.5	19.7	150.0	-17.6	Peak
181.20	H	180.00	4.00	12.10	13.2	18.4	150.0	-18.2	Peak
220.00	H	180.00	2.89	6.10	13.1	9.1	200.0	-26.8	Peak