## Engineering Report 53010-1

# Vibration Test

**for**

## CHC Navigation

**Prepared by**

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**Approved by**

Kent L. Erickson, Manager, Vibration

## Revision history

| Revision | Total pages | Date | Description |
|---|---|---|---|
| -- | 15 | November 13, 2015 | Original |
| | | | |

| | | | |
|---|---|---|---|
| **Prepared for** | CHC Navigation | | |
| **Attention** | Mr. Lance Andre | **Test number** | 53010-1 |
| **Test start** | 11/2/2015 | **Test completion** | 11/3/2015 |
| **Purchase order number** | **15EMTCH01** | **Purchase date** | 11/3/2015 |

**Vibration Test**

## 1.0 Abstract

### 1.1 Object

Subject two Antennas, one i80 Pole Mounted GPS Unit, one N72 Machine Mounted Receiver, and one LT500 Handheld to a Vibration Test as specified in *MIL-STD-810G*, with Change 1, dated April 15, 2014, Method 514.7, General Minimum Integrity Test and Composite Two Wheeled Trailer Vibration, as requested in CHC Navigation purchase order 15EMTCH01, dated November 3, 2015.

### 1.2 Conclusions

Upon completion of the Vibration Test, the test units remained intact and appeared to have incurred no visible evidence of damage or degradation as a result of the test.

## 2.0 Unit(s) tested

**Table 2-1: Units tested**

| | | | | | |
|---|---|---|---|---|---|
| **Manufacturer** | CHC Navigation | | | | |
| **Device** | One (1) Antenna | One (1) Antenna | One (1) i80 Pole Mounted GPS Unit | One (1) N72 Machine Mounted Receiver | One (1) LT500 Handheld |
| **Model/part number** | 1902210514 | 1902210513 | 1180020032231 | 1172100000021 | 1250811223 |
| **Serial number** | 2015072007 | 2015031543 | 1000502 | 2000238 | 034578 |

*The results of this test apply only to the units identified in this Engineering Report by device identifier and model / part number, or serial number.*

## 3.0 Test requested

Subject two Antennas, one i80 Pole Mounted GPS Unit, one N72 Machine Mounted Receiver, and one LT500 Handheld to a Vibration Test as specified in *MIL-STD-810G*, with Change 1, dated April 15, 2014, Method 514.7, General Minimum Integrity Test and Composite Two Wheeled Trailer Vibration.

**General Minimum Integrity Test**

| Frequency (Hz) | Power spectral density |
|---|---|
| 20 | 0.04 g²/Hz |
| 1000 | 0.04 g²/Hz |
| 2000 | -6 dB/octave |

Overall acceleration: 7.7 grms

Duration: 1 hour in each of three mutually perpendicualr axes

| Vertical | | Transverse | | Longitudinal | |
|---|---|---|---|---|---|
| Frequency, Hz | PSD, $g^2$/Hz | Frequency, Hz | PSD, $g^2$/Hz | Frequency, Hz | PSD, $g^2$/Hz |
| 5 | 0.2252 | 5 | 0.0736 | 5 | 0.0521 |
| 8 | 0.5508 | 6 | 0.0438 | 7 | 0.1046 |
| 10 | 0.0509 | 7 | 0.0761 | 8 | 0.1495 |
| 13 | 0.0253 | 13 | 0.0130 | 13 | 0.0140 |
| 15 | 0.0735 | 15 | 0.0335 | 16 | 0.0303 |
| 17 | 0.0301 | 16 | 0.0137 | 18 | 0.0200 |
| 18 | 0.0319 | 21 | 0.0102 | 19 | 0.0342 |
| 19 | 0.0402 | 23 | 0.0268 | 20 | 0.0160 |
| 20 | 0.0366 | 25 | 0.0090 | 23 | 0.0378 |
| 43 | 0.1004 | 28 | 0.0090 | 27 | 0.0079 |
| 50 | 0.0308 | 30 | 0.0137 | 30 | 0.0208 |
| 102 | 0.0740 | 34 | 0.0055 | 32 | 0.0100 |
| 109 | 0.1924 | 37 | 0.0081 | 33 | 0.0267 |
| 117 | 0.0319 | 46 | 0.0039 | 35 | 0.0065 |
| 138 | 0.0869 | 51 | 0.0068 | 51 | 0.0040 |
| 150 | 0.0286 | 55 | 0.0042 | 53 | 0.0081 |
| 190 | 0.0605 | 106 | 0.0033 | 56 | 0.0035 |
| 263 | 0.0613 | 108 | 0.0045 | 59 | 0.0066 |
| 332 | 0.0097 | 111 | 0.0033 | 63 | 0.0037 |
| 360 | 0.0253 | 148 | 0.0030 | 65 | 0.0127 |
| 452 | 0.0053 | 163 | 0.0054 | 73 | 0.0026 |
| 500 | 0.0045 | 175 | 0.0023 | 93 | 0.0117 |
| | | 235 | 0.0013 | 109 | 0.1635 |
| rms = 4.43 g | | 262 | 0.0028 | 120 | 0.0180 |
| | | 265 | 0.0025 | 132 | 0.0320 |
| | | 317 | 0.0016 | 138 | 0.0738 |
| | | 326 | 0.0057 | 153 | 0.0236 |
| | | 343 | 0.0009 | 158 | 0.0549 |
| | | 384 | 0.0018 | 164 | 0.0261 |
| | | 410 | 0.0008 | 185 | 0.0577 |
| | | 462 | 0.0020 | 257 | 0.0062 |
| | | 500 | 0.0007 | 280 | 0.0032 |
| | | | | 304 | 0.0068 |
| | | rms = 1.30 g | | 323 | 0.0045 |
| | | | | 343 | 0.0193 |
| | | | | 386 | 0.0014 |
| | | | | 444 | 0.0054 |
| | | | | 476 | 0.0018 |
| | | | | 490 | 0.0046 |
| | | | | 500 | 0.0014 |
| | | | | rms = 2.86 g | |

**Figure 3-1: Composite Two Wheeled Trailer Vibration Test (Table 514.6C-IV, *MIL-STD-810G*)**

## 4.0 Instrumentation, procedure, and results

### 4.1 Instrumentation

All instrumentation is calibrated regularly by instruments directly traceable to the National Institute of Standards and Technology, and in accordance with *MIL-I-45208A, ANSI/NCSL Z540.3-2006,* and *ISO/IEC 17025: 2005*.

**Table 4-1: Instrumentation list**

| Equipment Number | Description | Manufacturer | Model Number | Last Calibration | Due Calibration | Range |
|---|---|---|---|---|---|---|
| 480-196 | ICP Accelerometer | PCB Piezotronics | 352C41 | 5/7/2015 | 5/7/2016 | 0 to 500g; 0.5 Hz to 10 KHz |
| 480-199 | ICP Accelerometer | PCB Piezotronics | 352C41 | 5/21/2015 | 5/21/2016 | 0 to 500g; 0.5 Hz to 10 KHz |
| 503-217 | Vibration Controller System | Vibration Research Corporation | VR9500 | 8/27/2015 | 8/27/2016 | N/A |
| 503-221 | Vibration Exciter / Amplifier | Unholtz-Dickie | T2000 / SAT180-T2000-3 / CSTA | N/A | N/A | 20,000 force lbs; 3 in D.A.; 5 to 3000 Hz. |

### 4.2 Procedure

The test units were first secured to a head expander, which was coupled to the vertically oriented exciter. Two control accelerometers were cemented to the head expander, and the General Minimum Integrity Test, followed by the Composite Two Wheeled Trailer Vibration Test, was conducted in the vertical axis.

The test units were secured to the horizontally oriented slip plate, and then rotated 90 degrees on the slip plate, and testing was conducted in the longitudinal and transverse axes, respectively, in the same manner as testing in the vertical axis.

### 4.3 Results

Upon completion of the Vibration Test, the test units remained intact and appeared to have incurred no visible evidence of damage or degradation as a result of the test.

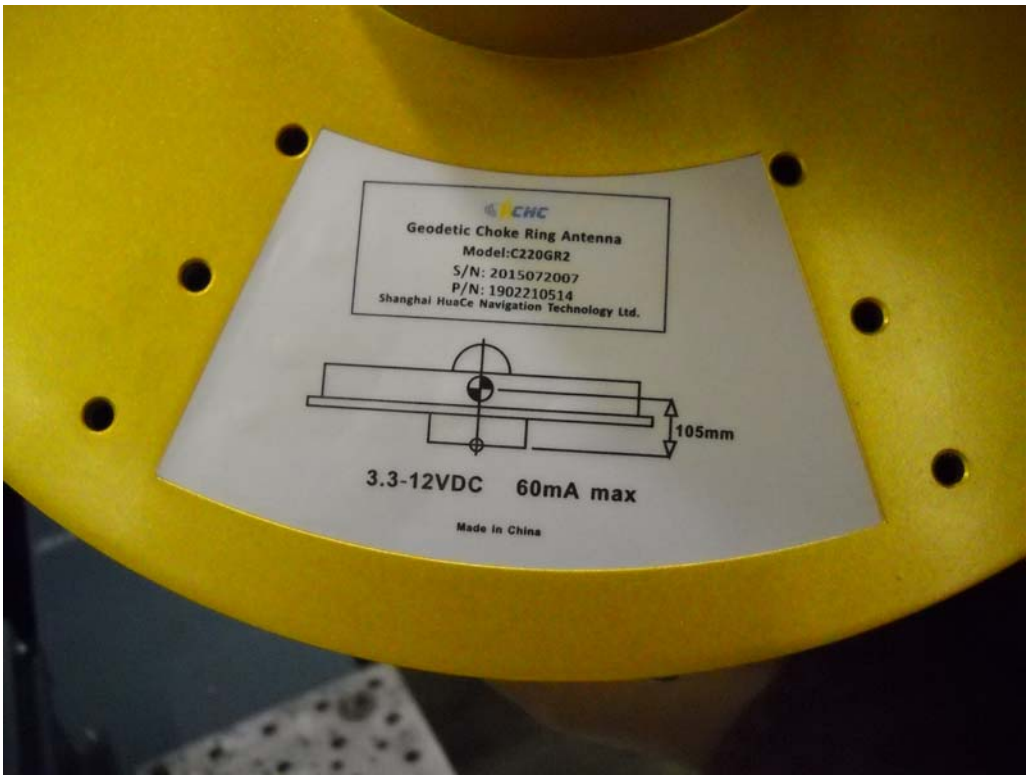
The test units were returned to CHC Navigation.

Figures of test data and photographs are included in the following pages.


Photograph 4-1: Test unit identification

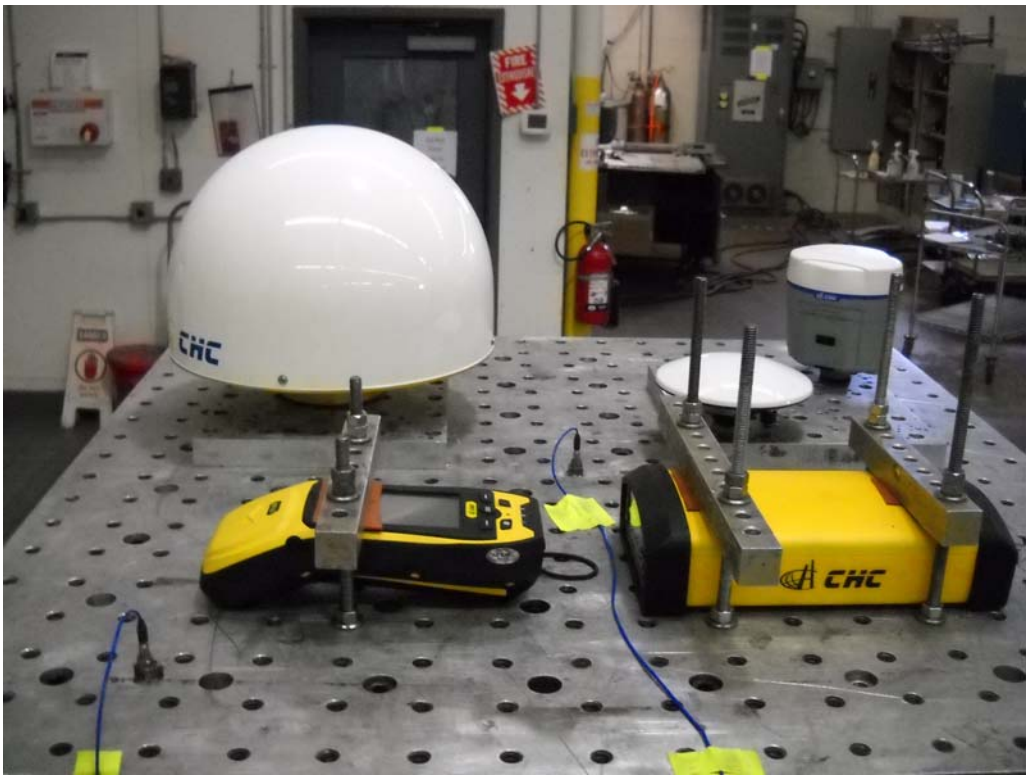

Photograph 4-2: Test unit identification

Photograph 4-3: Test unit identification

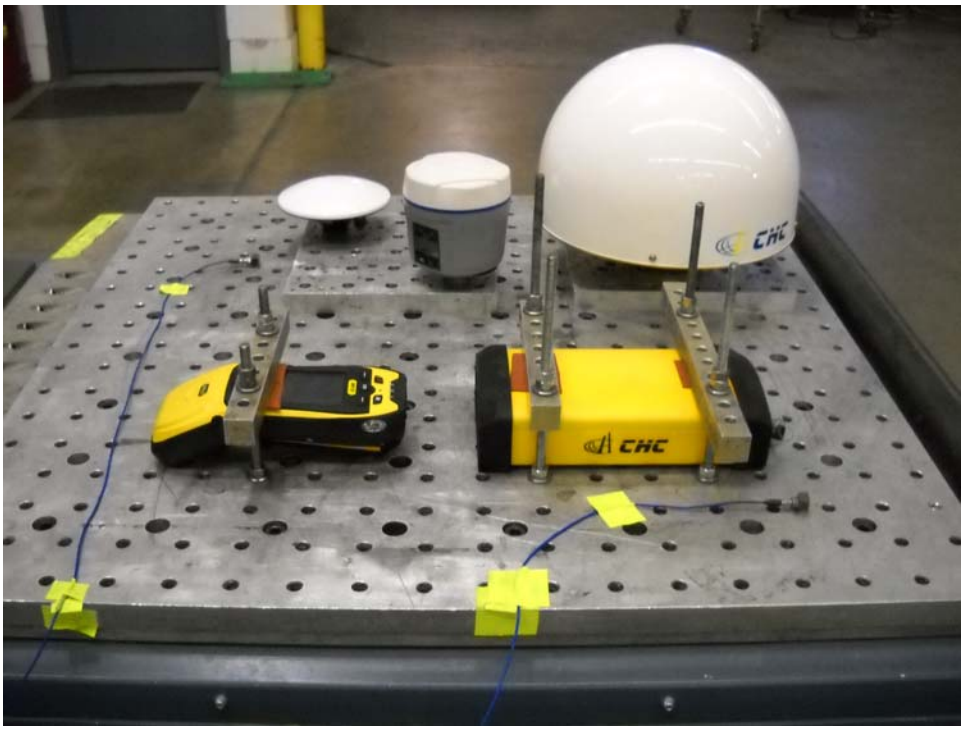



Photograph 4-4: Test unit identification

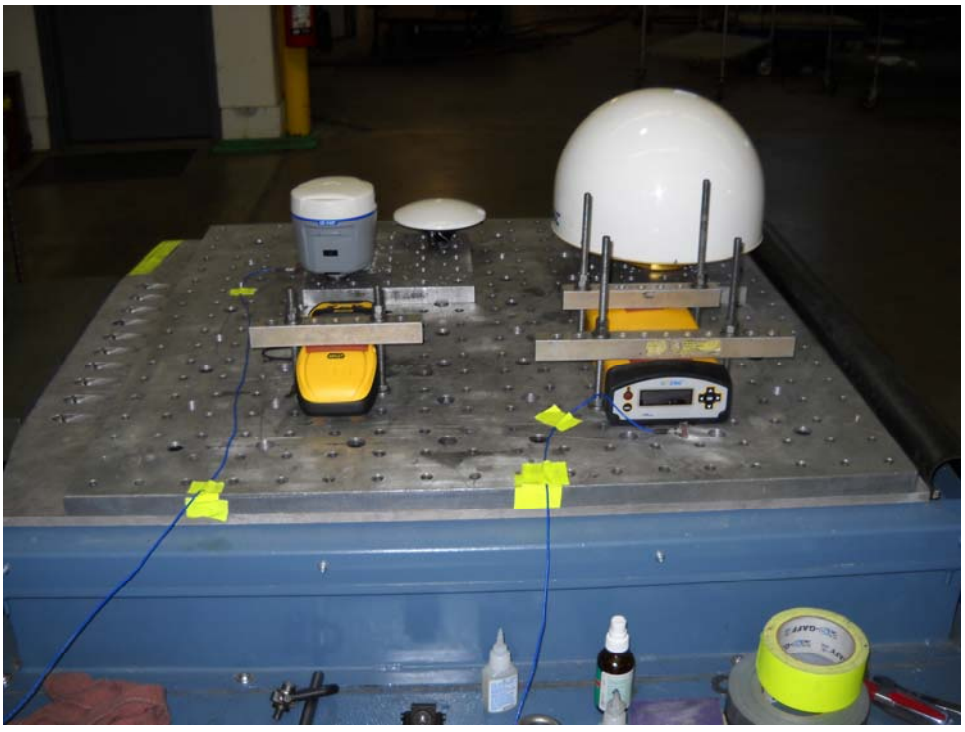

Photograph 4-5: Test unit identification




Photograph 4-6: Test units secured to the head expander and ready for testing in the vertical axis. The control accelerometers are visible, cemented to the head expander. Applied motion is up-and-down as this photograph is viewed.



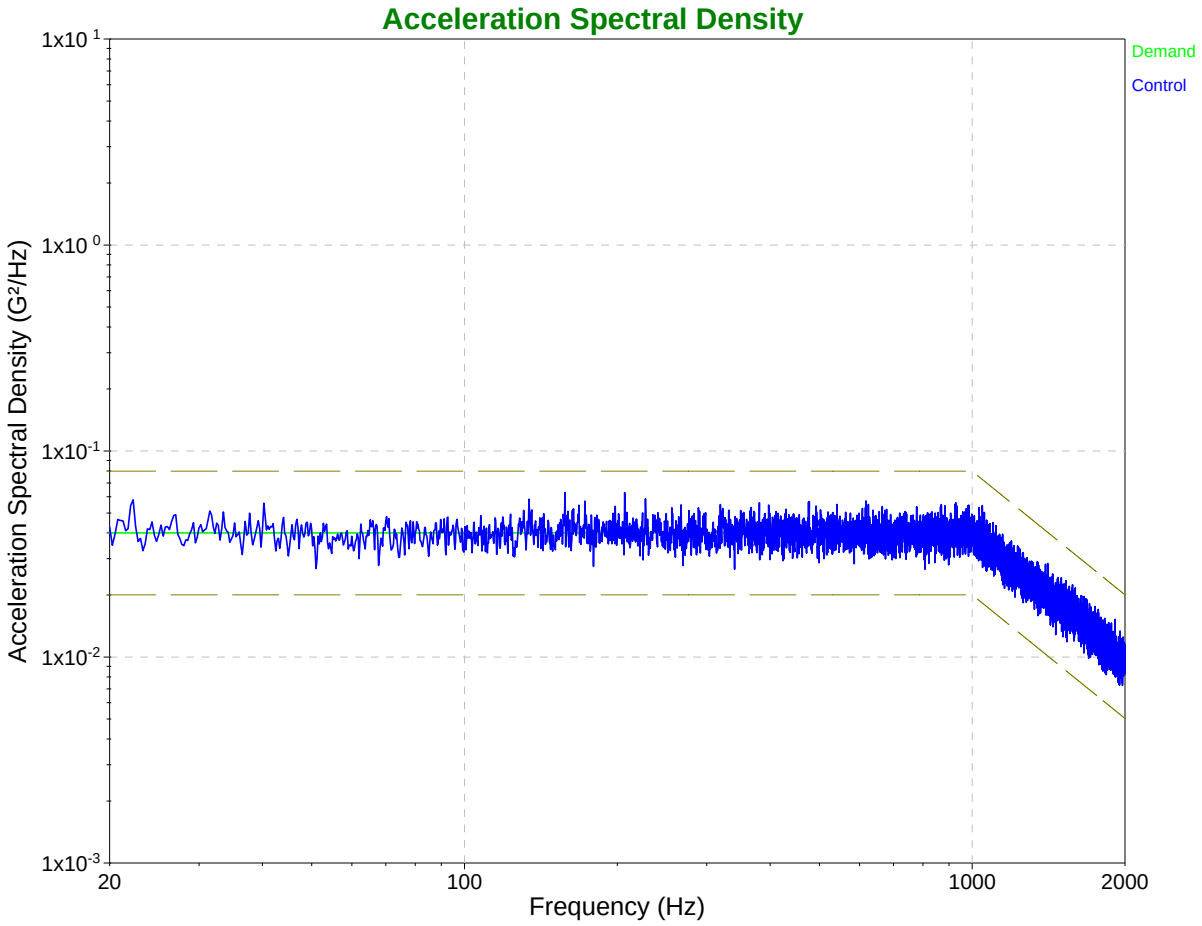

Photograph 4-7: Test units secured to the slip plate and ready for testing in the longitudinal axis. The control accelerometers are visible, cemented to the slip plate. Applied motion is left-to-right as this photograph is viewed.



Photograph 4-8: Test units secured to the slip plate and ready for testing in the transverse axis. The control accelerometers are visible, cemented to the slip plate. Applied motion is left-to-right as this photograph is viewed.

Customer: CHC Navigation
Job#: 53010

Data: C:\VibrationVIEW\Data\2015-11\2015Nov02-1106-0013.vrd
Test: C:\VibrationVIEW\Profiles\53010.vrp
Data stored on Nov 02, 2015 12:08:18
CHC Navigation MIL-STD-810G Minimum Integrity Test - Vertical Axis -
***End of Test***




*Breakpoint table*

| Frequency | G²/Hz | dB/Octave |
|---|---|---|
| 20 Hz | 0.04 | 0 |
| 1000 Hz | 0.04 | -6 |
| 2000 Hz | 0.01005 | |

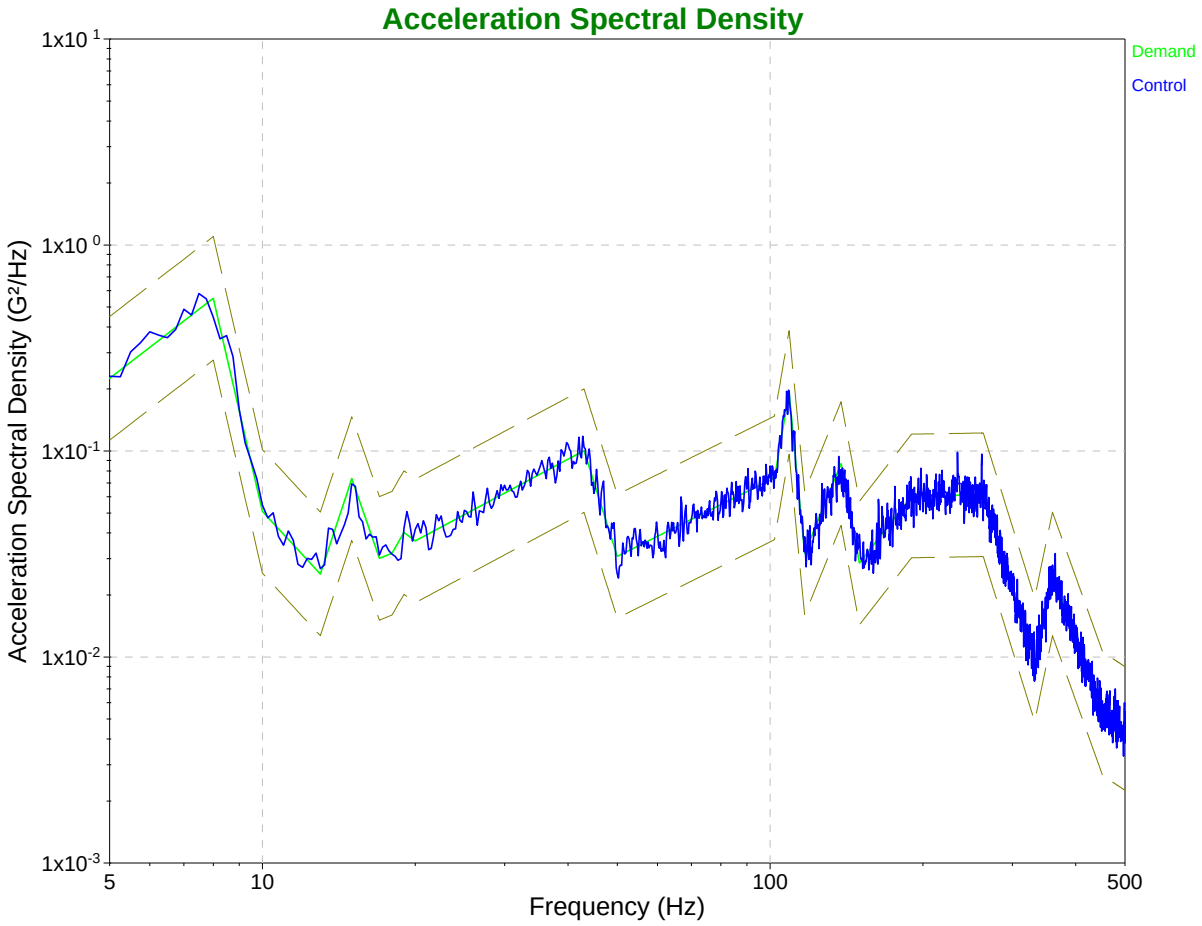
*Test level schedule:*

| | Duration | Level |
|---|---|---|
| 1) | 1:00:00 | 100 % |

** Test started Nov 02, 2015 11:06:27, running for 1:01:51
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00

Customer: CHC Navigation
Job#: 53010

Data: C:\VibrationVIEW\Data\2015-11\2015Nov02-1307-0013.vrd
Test: C:\VibrationVIEW\Profiles\53010V.vrp
Data stored on Nov 02, 2015 14:09:00
CHN Navigation - Vertical Axis  Mil-STD-810G Method 514.6 Composite Two Wheeled Trailer Vibration -
***End of Test***



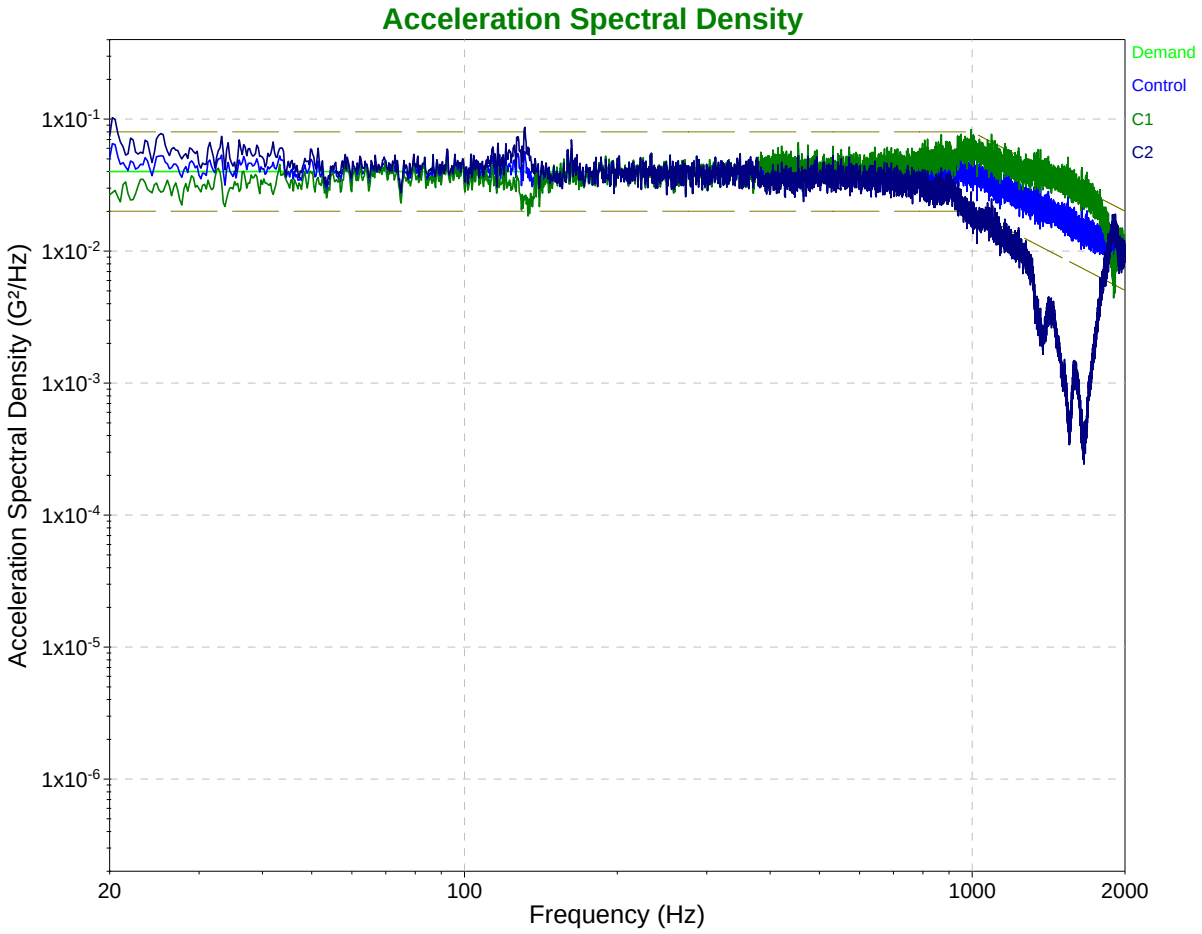

*Test level schedule:*

| | Duration | Level |
|---|---|---|
| 1) | 1:00:00 | 100 % |

** Test started Nov 02, 2015 13:07:45, running for 1:01:15
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00

Customer: CHC Navigation
Job#: 53010

Data: C:\VibrationVIEW\Data\2015-11\2015Nov03-0605-0016.vrd
Test: C:\VibrationVIEW\Profiles\53010.vrp
Data stored on Nov 03, 2015 07:11:04
CHC Navigation MIL-STD-810G Minimum Integrity Test - Longitudinal Axis -
***End of Test***




*Breakpoint table*

| Frequency | G²/Hz | dB/Octave |
|---|---|---|
| 20 Hz | 0.04 | 0 |
| 1000 Hz | 0.04 | -6 |
| 2000 Hz | 0.01005 | |

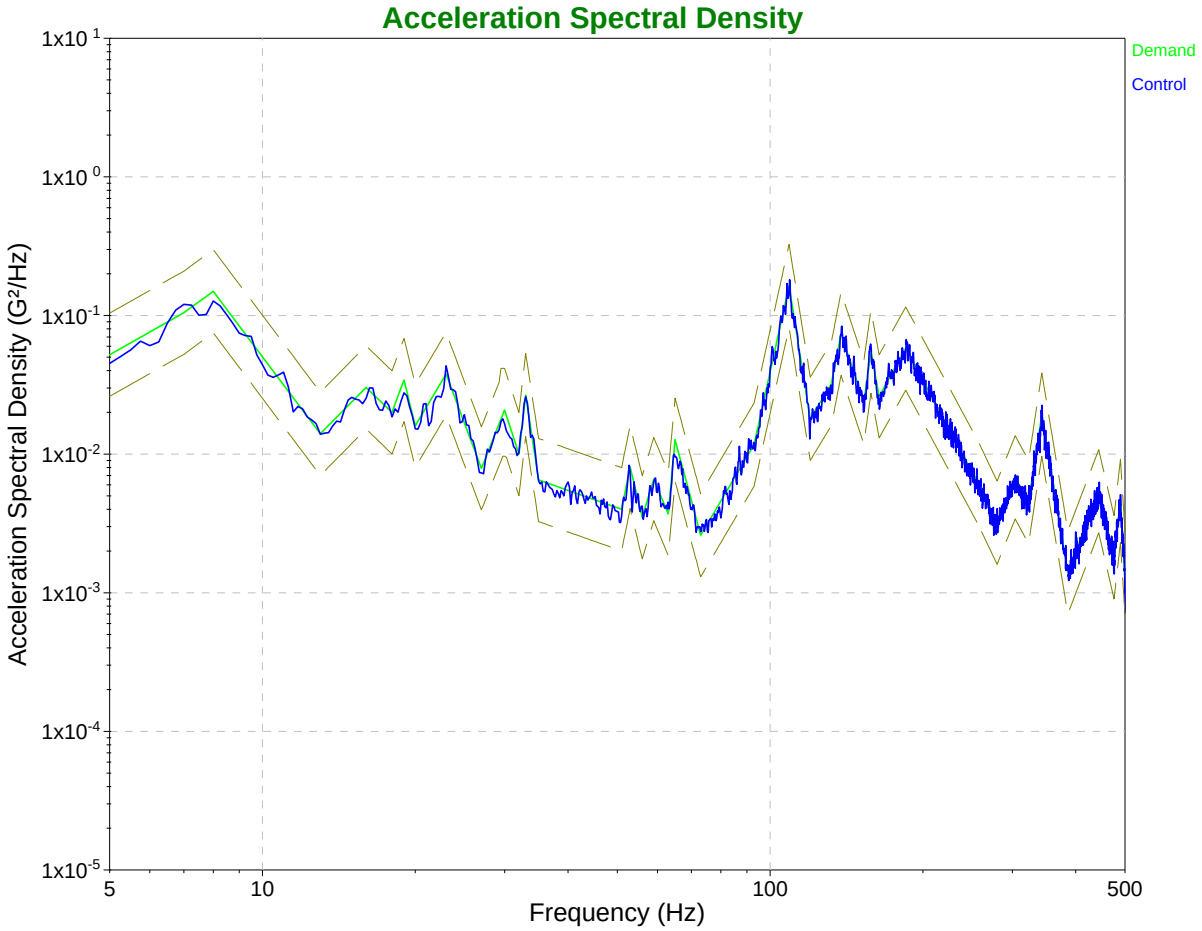
*Test level schedule:*

| | Duration | Level |
|---|---|---|
| 1) | 1:00:00 | 100 % |

** Test started Nov 03, 2015 06:05:34, running for 1:03:48
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00

Customer: CHC Navigation
Job#: 53010

Data: C:\VibrationVIEW\Data\2015-11\2015Nov03-0839-0014.vrd
Test: C:\VibrationVIEW\Profiles\53010L.vrp
Data stored on Nov 03, 2015 09:43:23
CHC Navigation - Longitudinal Axis MIL-STD-810G Composite Two Wheeled Trailer -
***End of Test***



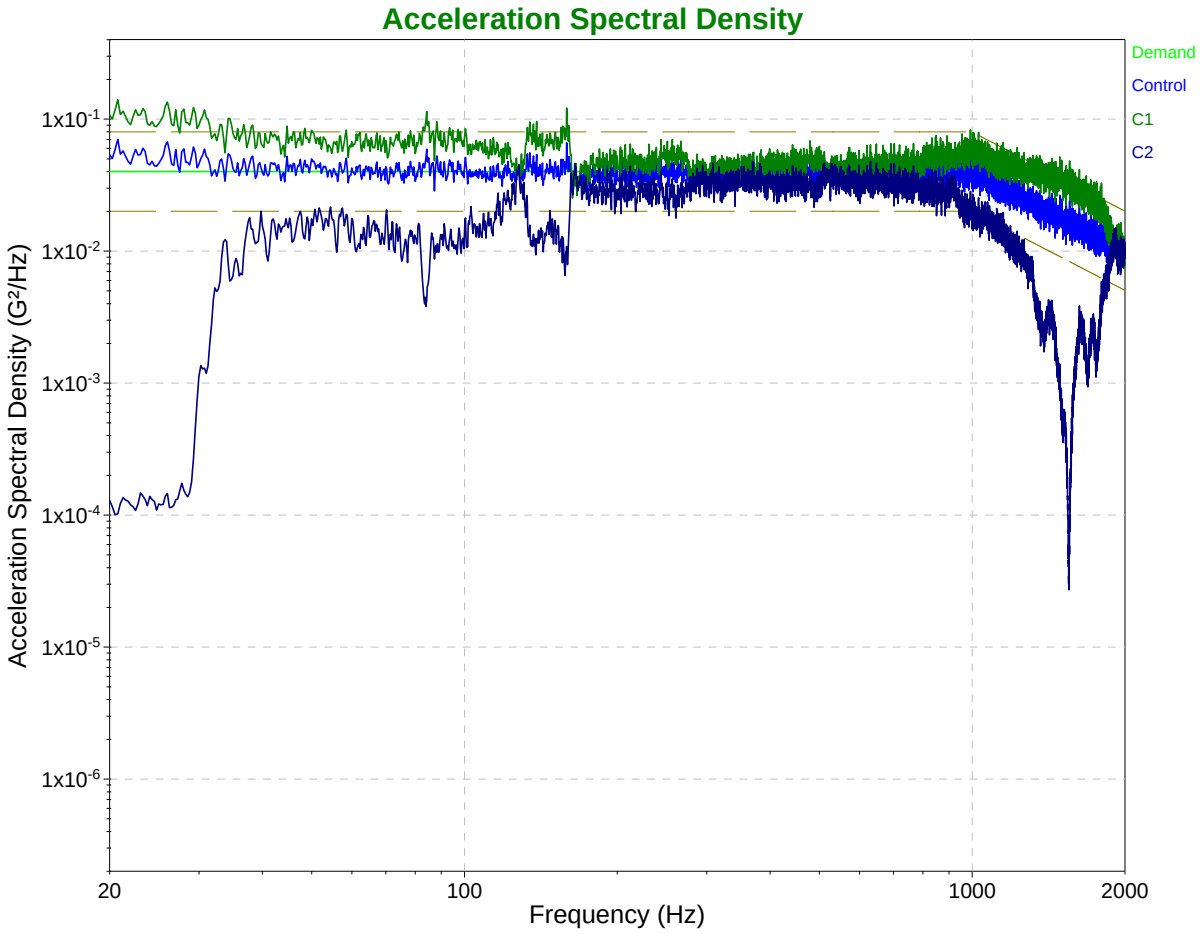

*Test level schedule:*

| | Duration | Level |
|---|---|---|
| 1) | 1:00:00 | 100 % |

** Test started Nov 03, 2015 08:39:09, running for 1:02:17
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00

Customer: CHC Navigation
Job#: 53010

Data: C:\VibrationVIEW\Data\2015-11\2015Nov03-0952-0015.vrd
Test: C:\VibrationVIEW\Profiles\53010.vrp
Data stored on Nov 03, 2015 10:58:25
CHC Navigation MIL-STD-810G Minimum Integrity Test - Transverse Axis -
***End of Test***




*Breakpoint table*

| Frequency | G²/Hz | dB/Octave |
|---|---|---|
| 20 Hz | 0.04 | 0 |
| 1000 Hz | 0.04 | -6 |
| 2000 Hz | 0.01005 | |

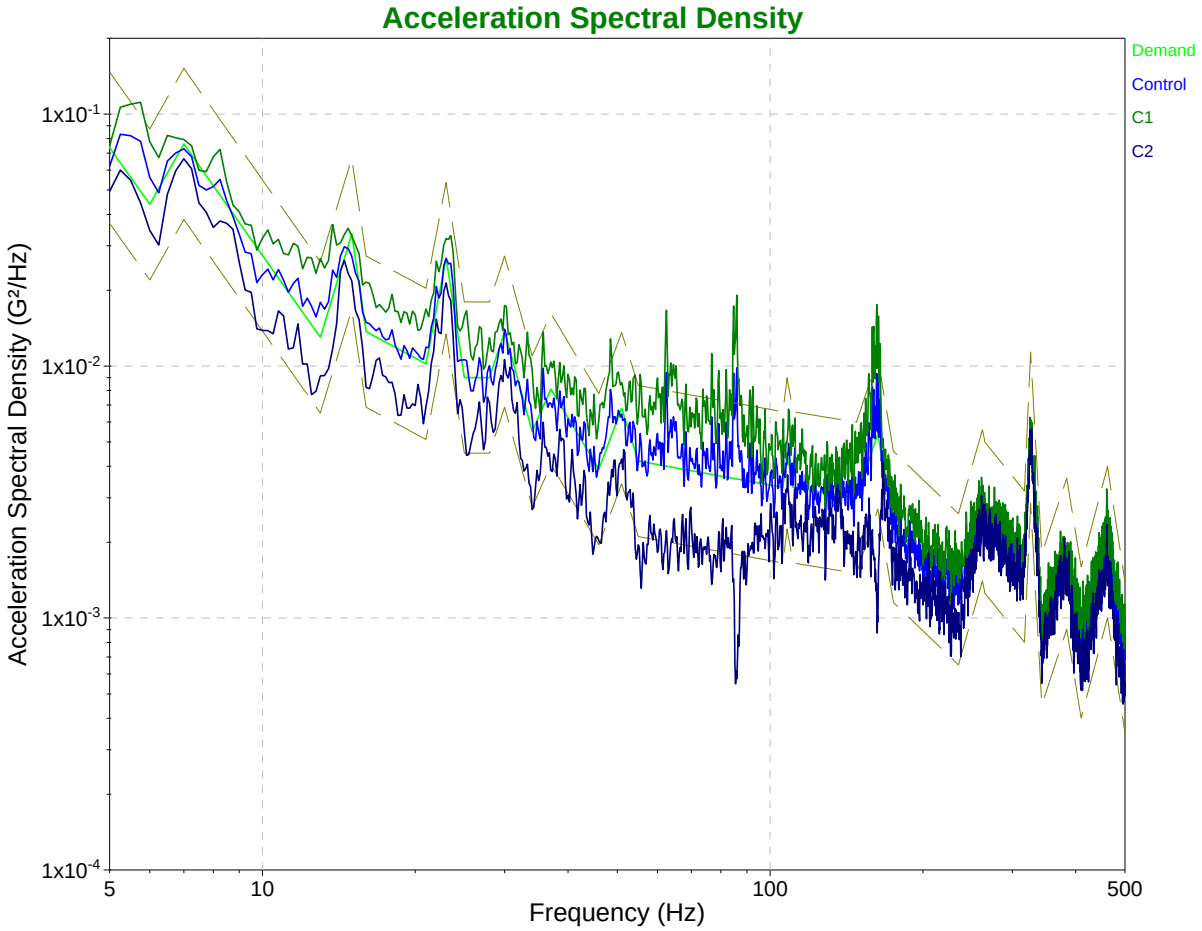
*Test level schedule:*

| | Duration | Level |
|---|---|---|
| 1) | 1:00:00 | 100 % |

** Test started Nov 03, 2015 09:52:19, running for 1:05:40
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00

Customer: CHC Navigation
Job#: 53010

Data: C:\VibrationVIEW\Data\2015-11\2015Nov03-1101-0013 (2).vrd
Test: C:\VibrationVIEW\Profiles\53010T.vrp
Data stored on Nov 03, 2015 12:04:39
CHC Navigation - Trsnsverse Axis  Mil-STD-810G Method 514.6 Composite Two Wheeled Trailer -
***End of Test***




*Test level schedule:*

| | Duration | Level |
|---|---|---|
| 1) | 1:00:00 | 100 % |

** Test started Nov 03, 2015 11:01:51, running for 1:02:48
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00