STEREO BOOM Vibration Test Procedure
Document # IMP-562-DOC

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REVISION: A
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1. OBJECTIVE

The objective of this vibration test is to subject the STEREO Boom (hereafter referred to as the Unit Under Test, UUT) to Flight vibration levels, qualifying the general mechanical integrity of the UUT at the component level, and verifying the UUT is capable of maintaining functionality following vibration.

The UUT will be the fully assembled Flight or Protoflight Boom, including the Boom Tube Assembly, SMAR Pin Puller Device, Cables, and instruments or mass dummies replacing instruments, as required. The UUT will be deployed following vibration testing to verify functionality.

Test was performed for the Protoflight Boom by Wyle Labs (El Segundo, CA) the Summer of 2003.

Test will be performed for the Flight Model Booms (FM1 and FM2) by Wyle Labs (Santa Clara, CA) in April of 2004.

This test procedure is to be used for both the Flight and Protoflight units. The difference between the two tests' regimen is the hardware configuration of the particular assemblies. Both flight units are tested with the STE-U and Magnetometer instruments installed. This configuration provides a more flight-like arrangement for the instruments and Boom.

2. PERSONNEL

Test Attendees:

Test Conductors _____
(UCB)Ullrich/McCauley

Test Engineer _____ _____
(Wyle Labs)

3. REFERENCE DOCUMENTS

APL Document APL 7381-9003 Rev A
UCB STEREO/IMPACT Boom Verification Plan

4. VIBRATION TEST LEVELS

The vibration spectrums, levels, and durations for this test will be per Addendums. Test shall be run in all three axes, applied independently.

Protoflight Units will be vibrated to spectra as provided in APL Document #7381-9003, "STEREO Environmental Definition, Observatory, Component and Instrument Test Requirements," with force limiting enabled for random vibration tests.

Flight Units will be vibrated as provided in the above document with the random spectra notched to approximate the Control Input to the Protoflight Units during force limited testing.

5. PASS/FAIL CRITERIA

UUT has successfully passed vibration testing if the unit is not degraded mechanically, functionally, or structurally. Success criteria shall consist of:

- No lost of functionality in Boom Assembly Deployment (functional testing to occur following vibration testing at UCB during Thermal Vacuum Cycling), significant verified parameters include: actuation time, deployment time, full deployment and lockup by inspection, stiffness, and alignment
- No significant change in pre- and post- sine sweep signatures
- No permanent deformations, movements, or degradations
- No loss of connectivity of cable harness (measured before and after each test), conductivity must be maintained
- No loss of functionality in Magnetometer or STE-U function or utility. Comprehensive Performance Tests (CPTs) will be performed at UCB/SSL before testing commences and after testing is complete.

Verification will consist of visual inspections, inspection of accelerometer output data, and acceptable functional deployment. Note: it is not possible to codify a completely comprehensive PASS/FAIL Criteria for this type of Vibration Data. Test Conductor along with UCB/SSL STEREO Project Manager shall evaluate all test data.

6. REQUIRED HARDWARE ITEMS FOR TEST

UUT Consisting of Boom Assembly, Cables, and Instruments or Mass Dummies in lieu of Instruments. (Items removed/not in place for Vibration Testing include Thermal Blankets and Instruments as required.)

All Flight Items are in final Flight configuration.

7. TEST ABORT AND REAL TIME ACTIVITY ASSESSMENT

Testing shall continue with the goal of a one (1)day test cycle. Minor anomalies will be evaluated and, where prudent, fixed or alleviated in an attempt to continue testing. Examples of minor anomalies include temporary loss of accelerometer data, minor problems with hardware (cable movement) or problems with shaker facility. Disposition of minor anomalies will be made by Test Conductors at test site.

Significant anomalies will result in abort of further testing. Abort decisions will be made only after consultation with STEREO Project Manager. The UCB Test Engineer has authority to stop testing if deemed damage may be occurring to the hardware, the testing equipment functioning is suspect, output data is questionable, or the test is not compatible with this procedure.

All anomalies shall be reported as part of standard Project Problem/Failure Reporting.

8. POST-VIBRATION TESTING at SSL

UUT success in vibration testing will be demonstrated at SSL after the completion of this test sequence by:

- CPT of Magnetometer without anomalies
- CPT of STE-U without anomalies
- Boom harness conductivity test.
- Deployment of the Boom without anomalies. Verify: actuation time, deployment time, full deployment and lockup by inspection, stiffness, and alignment. This test will occur during the hot cycle of Thermal Vacuum Cycling Tests. Refer to UCB Document IMP-563-DOC, Thermal Vac Cycling Test Plan, Revision A."

9. TEST PREPARATION ACTIVITIES at UCB/SSL

Initials	*Description.*
	Complete assembly of Boom. Photograph.
	Test Deployment of complete assembly. Measure actuation time, deployment time, full deployment and lockup by inspection, stiffness, and alignment.
	Install Boom Test Harness. Perform CPT of Magnetometer and STE-U Instruments (Flight Only)
	Double bag UUT, leaving access to accelerometer locations and leads to internally mounted accelerometers. Photograph.
	Transport UUT and support hardware to test facility.

INSPECTION POINT
INSTRUMENT IS COMPLETE AND READY FOR SHIPMENT TO TESTING FACILITY

***INSPECTION POINT* DATA RECORDED BY:** _____

10. PRE-TEST ACTITIVIES at FACILITY

Prior to the start of each axis test:

X	*Y*	*Z*	*Description.*
			Properly orient Vibration Table for test.
			Install control accelerometer on Vibration Table. Mark up figure to show actual placement. Label accelerometer **CTL**.
			Prepare **Table Sine Survey**. Load and verify control settings. Annotate data with appropriate Run#.
			Perform **Table Sine Survey**. Note any prominent resonance features.
			Perform RANDOM Vibration Run to verify working of table.
			Perform any other vibration runs at discretion of Test Conductor on empty vibration table. As a minimum, a Sine Survey and Random shall be performed to ensure adequacy of software, electronics, and the table itself.
			Mount UUT vibration fixture plate to Vibration Table.
			Install all fasteners in vibration fixture plate.
			Verify torque of all fasteners.
			Install accelerometer on UUT, locations per Figure 1. Mark up figure to show actual placement. Label accelerometers.
			Attach cables from accelerometers to recording amplifiers.
			Verify response of all accelerometers. Verify accelerometer assignments in system controller. Record accelerometer sensitivity in Table 1 below.
			Photograph vibration configuration.
			Assign run numbers for each vibration event and record.

***INSPECTION POINT* DATA RECORDED BY**: _____

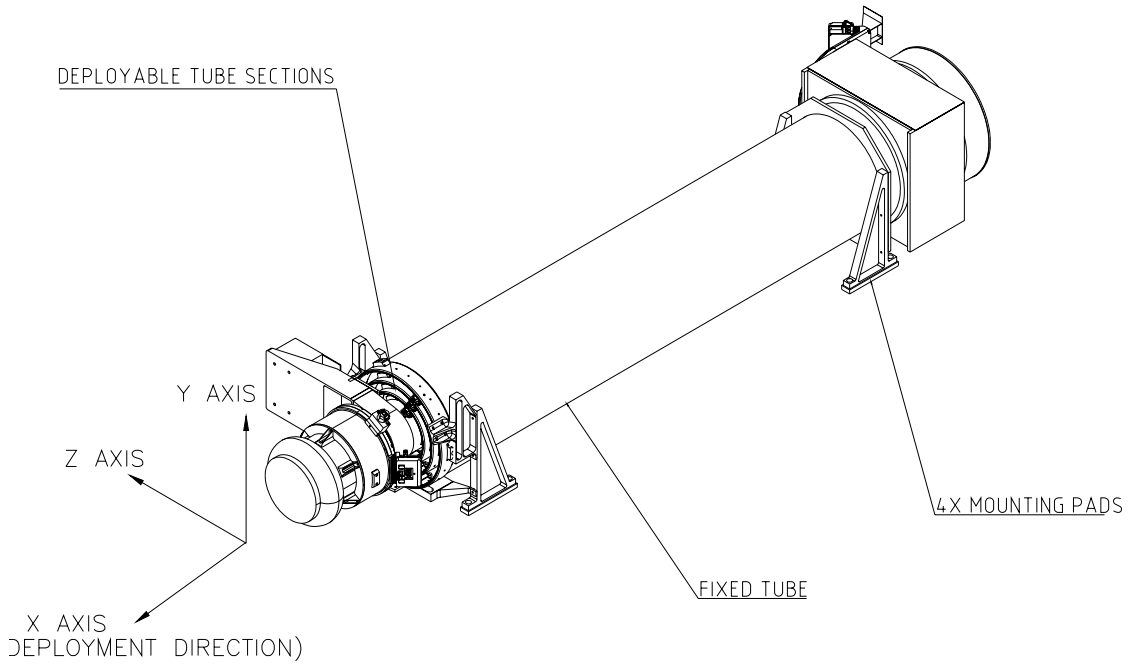
Table 1: Accelerometer Sensitivity

Accel S/N	**Sensitivity (pC/g @ 100Hz)**		
	X	**Y**	**Z**

***INSPECTION POINT* DATA RECORDED BY:** _____

Sketch UUT and accelerometer locations in following drawings.
Note: A minimum of 6 accelerometers recording output data should be used.

INSPECTION POINT DATA RECORDED BY: _____



10. VIBRATION TESTING

Choice of axis sequence is optional. Following satisfactory inspection of UUT on table, perform vibration testing per spectrums and sequencing listed in Addendum A. The UUT is to be "powered as launched" during vibration testing. Attach Harness to ETU IDPU, 28V supply, and monitoring equipment for all runs. Monitor current for transients.

Record Run# in the check boxes below:

X	*Y*	*Z*	*Description*
			Install vibration fixture for Boom onto vibration table.
			Install UUT on vibration fixture, torque fasteners, as shown in Addendum E.
			Verify torque of vibration fixture fasteners.
			Verify proper mounting of accelerometers.
			Prepare **Sine Survey #1 per Addendum A**. Load and verify control settings. Annotate data with appropriate Run#.
			Perform **Sine Survey #1**. Note any prominent resonance features.
			Prepare **Sine Strength Test per Addendum B**. Load and verify control settings. Annotate data with appropriate Run#.
			Perform **Sine Strength Test**. Calculate g loads on any resonance features.
			Prepare **Sine Survey #2**. Load and verify control settings. Annotate data with appropriate Run#.
			Perform **Sine Survey #2**. Compare to Preliminary.
			Prepare **Random Vibration per Addendum C**. Load and verify control settings. Annotate data with appropriate Run#.
			Perform **Random Vibration**: ramp slowly to full level (-12, -9, -6, -3, 0 dB). Dwell for acceptance duration per Addendum A at 0 dB.
			Prepare **Sine Survey #3**. Load and verify control settings. Annotate data with appropriate Run#.
			Perform Sine Survey #3. Compare to Sine Survey #1.
			Record notes in the table on following page.

11. ON-SITE INSPECTIONS

Before, during, and after each vibration run, visual inspections are to be made to check hardware status. Test runs are to be aborted when hardware appears anomalous. Following each run, bolt torque measurements for bolts holding the UUT to the vibration plate shall be made to verify no backing out of bolts.

Table 2: Vibration Test Notes

Time	*Log#*	*Accel#*	*Feature Frequency*	*Feature Amplitude*	*Q*	*g*	*Notes*

Table 2: Vibration Test Notes

Time	*Log#*	*Accel#*	*Feature Frequency*	*Feature Amplitude*	*Q*	*g*	*Notes*

12. TEST DISPOSITION AND SUMMARY NOTES

Event #	Who	NOTES

ADDENDUM A: VIBRATION SPECIFICATIONS: SINE SURVEY
Protoflight and Flight Units

Testing Sequences

Testing is to be performed in the following order; identical sequence in all axes. Axes order optional.

a.	Mounting on Vibration Table
b.	Visual Inspection
c.	Sine Survey #1
d.	Sine Strength Test
e.	Sine Survey #2
f.	Random Vibration
g.	Sine Survey #3
h.	Visual Inspection
i.	[Repeat, other two axes]

Sine Survey (All Axes)

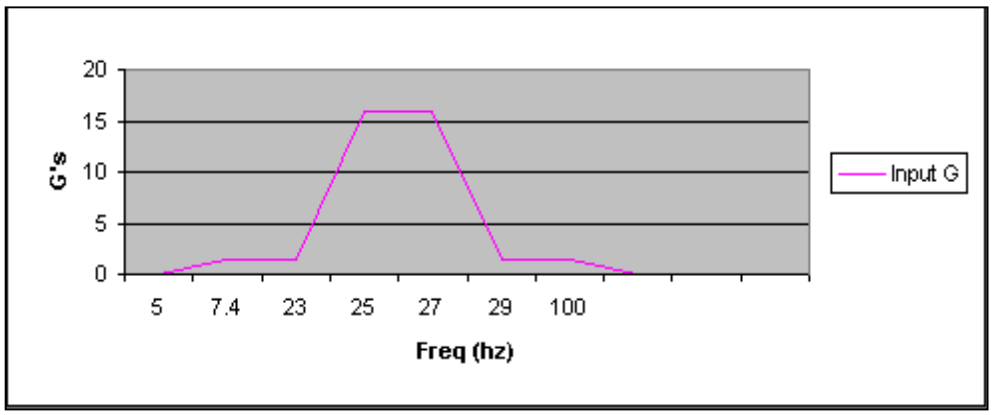
Frequency (Hz)	Acceleration
5-2000	0.1 g

Rate: 4 Octaves/Minute

ADDENDUM B: VIBRATION INPUTS: SINE STRENGTH TEST
Protoflight and Flight Units: 4 Octaves/Minute

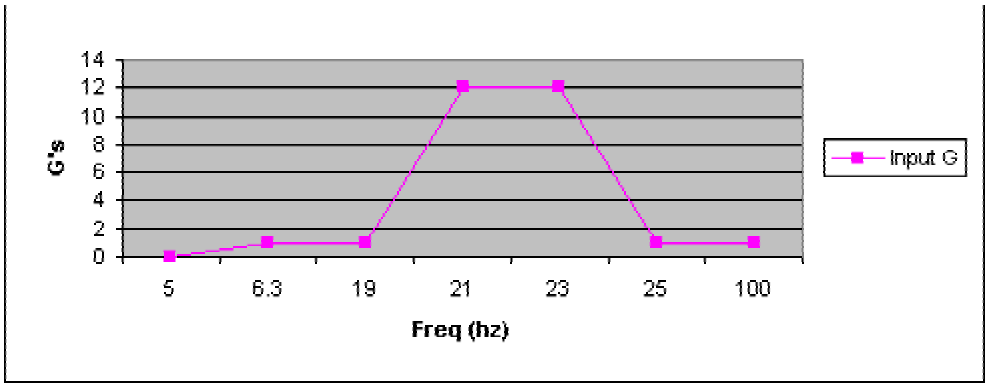
Thrust Axis

Freq	G
5-7.4	[.5" DA]
7.4	1.4
23	1.4
25	16
27	16
29	1.4
100	1.4



Lateral Axes

Freq	G
5-6.3	[.5" DA]
6.3	1
19	1
21	12
23	12
25	1
100	1



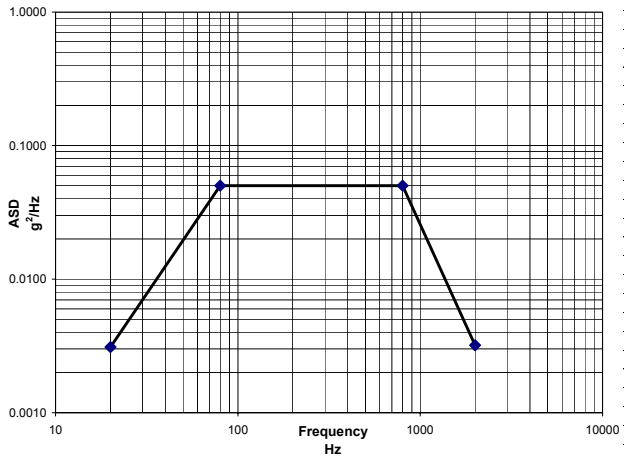
ADDENDUM C: VIBRATION INPUTS: RANDOM VIBRATION SPECTRA

Protoflight Units with Force Limiting

All three Axes

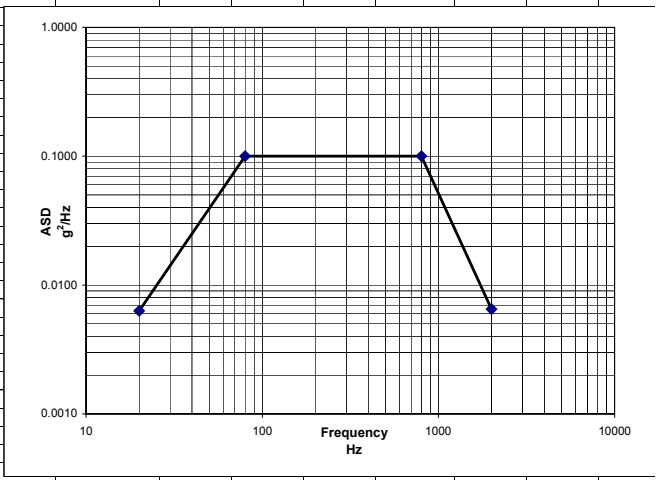
Random Vibration Specification
STEREO BOOM
REF: APL 7381-9003 REV A
Duration: 60 Seconds
Axis: Parallel to S/C Mounting Panel

				Slope	Acceleration	
FREQ(Hz)	**ASD(G^2/Hz)**	**dB**	**OCT**	**dB/OCT**	**AREA**	**Grms**
20	0.0031	*	*	*	*	*
80	0.0500	12.08	2.00	6.04	1.31	1.14
800	0.0500	0.00	3.32	0.00	37.31	6.11
2000	0.0032	-11.94	1.32	-9.03	54.11	**7.36**



Random Vibration Specification
STEREO BOOM
REF: APL 7381-9003 REV A
Duration: 60 Seconds
Axis: Perpendicular to S/C Mounting Panel

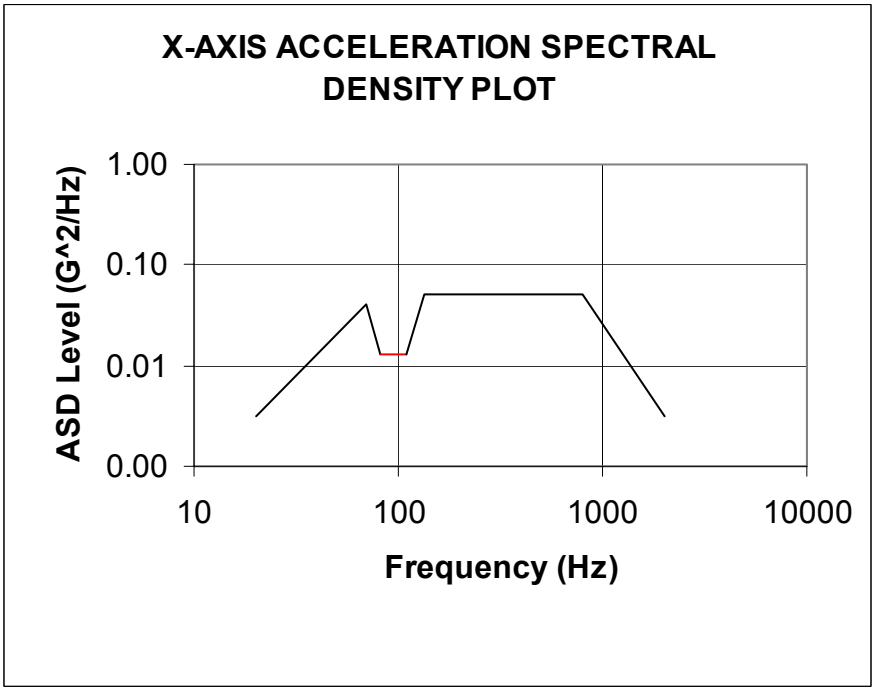
				Slope	Acceleration	
FREQ(Hz)	**ASD(G^2/Hz)**	**dB**	**OCT**	**dB/OCT**	**AREA**	**Grms**
20	0.0063	*	*	*	*	*
80	0.1000	12.01	2.00	6.00	2.63	1.62
800	0.1000	0.00	3.32	0.00	74.63	8.64
2000	0.0065	-11.87	1.32	-8.98	108.42	**10.41**



ADDENDUM D: VIBRATION INPUTS: RANDOM VIBRATION SPECTRA
Flight Units with Notched Spectra

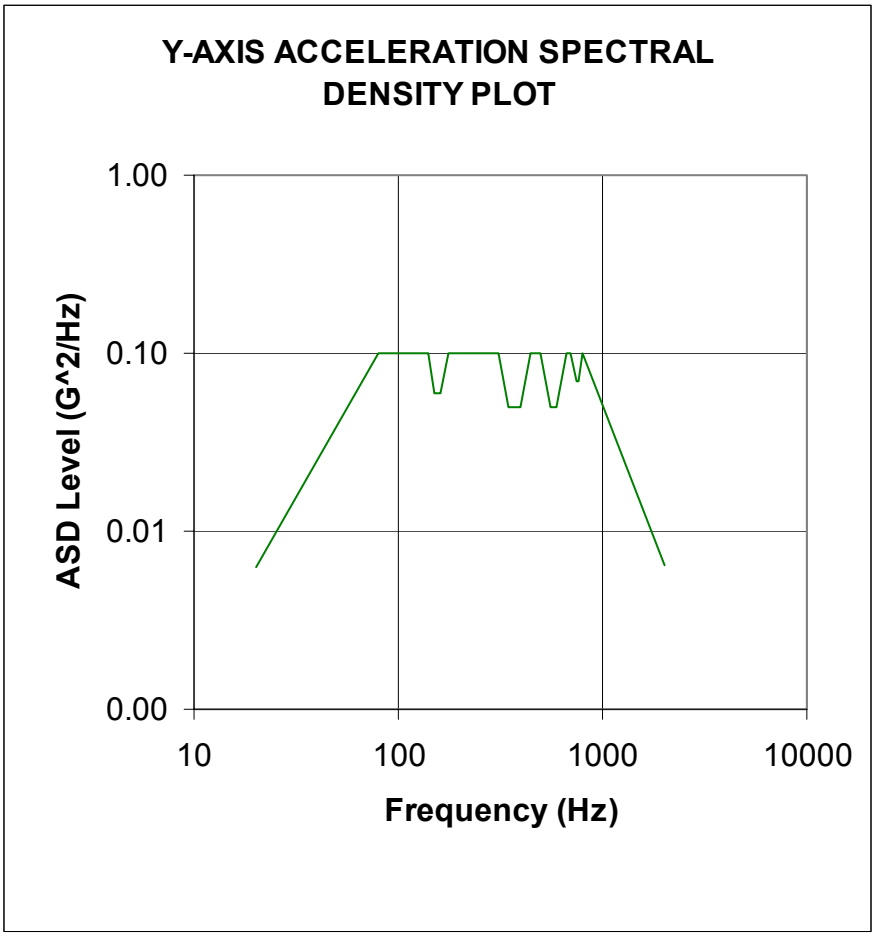
X-Axis
Duration: 60 seconds

frequency (Hz)	ASD (G^2/Hz)
20	0.0031
70	0.0400
81	0.0130
110	0.0130
135	0.0500
800	0.0500
2000	0.0032



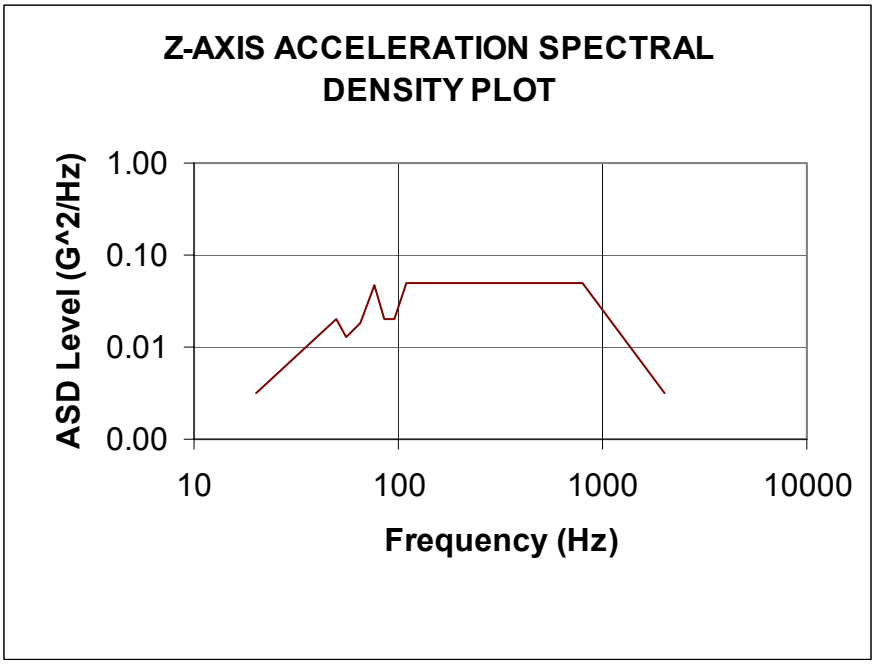
Y-Axis
Duration: 60 seconds

Frequency (Hz)	ASD (G^2/Hz)
20	0.0063
80	0.1000
140	0.1000
150	0.0600
160	0.0600
175	0.1000
310	0.1000
350	0.0500
400	0.0500
440	0.1000
500	0.1000
550	0.0500
600	0.0500
670	0.1000
700	0.1000
740	0.0700
760	0.0700
800	0.1000
2000	0.0065



Z-Axis

Frequency (Hz)	ASD (G^2/Hz)
20	0.0031
50	0.0200
55	0.0130
65	0.0180
75	0.0400
77	0.0470
86	0.0200
95	0.0200
110	0.0500
800	0.0500
2000	0.0032



ADDENDUM E: HARDWARE CONFIGURATION