DNEPR

Safety Compliance Requirements

(DSCR)

Version 1.0

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Version	Date	Authored by
.4	12.31.03	Armen Toorian, Roland Coelho
.5	1.28.04	Simon Lee
.6	8.5.04	Roland Coelho
1.0	8.6.04	Armen Toorian

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Safety Compliance Requirements

1 Vibration Compliance

One of the goals of the CubeSat Project is to ensure the safety of all satellites during launch. To accomplish this, the following vibration testing requirements will ensure that your hardware will not damage any satellites under the worst-case environmental conditions expected during launch. After testing, please send a copy of all attached forms to Cal Poly. Fax: (805) 756 - 5087

1.1 Vibration Testing

1.1.1 Vibration testing must be done with a Test Pod provided by Cal Poly. To request a Test Pod, please contact Dr. Jordi Puig-Suari at jpuigsua@calpoly.edu.

1.1.2 Insert the test satellite into the Test Pod following the procedures outlined in the Test Pod User's Guide, which can be found at http://cubesat.calpoly.edu/documents.htm.

1.1.3 Setup Test Pod so that the X axis is the test axis of the shake table. Then run the High Level DNEPR qualification test for 35 seconds, then the Low Level DNEPR qualification test for 831 seconds.

DNEPR High Level Qualification Profile:

LOWER FREQ. (Hz)	20	40	80	160	320	640	1280
HIGHER FREQ. (Hz)	40	80	160	320	640	1280	2000
SPECTRAL DENSITY	0.011	0.011	0.033	0.053	0.053	0.053	0.026

DNEPR Low Level Qualification Profile:

LOWER FREQ. (Hz)	20	40	80	160	320	640	1280
HIGHER FREQ. (Hz)	40	80	160	320	640	1280	2000
SPECTRAL DENSITY	0.011	0.011	0.011	0.014	0.014	0.007	0.007

1.1.4 Switch the setup to the Y axis and run the High and Low level tests.

1.1.5 Switch the setup to the Z axis and run the High and Low Level tests.

1.1.6 Follow all necessary (non-CubeSat) procedures and documentation regarding vibration tables and related equipment to ensure a valid test.

1.2 Satellite Examination

1.2.1 It is important to examine the test satellite after the test has been completed. Ensure that all parts of the satellite are intact and deployables are properly secured. Below is a list of things to look for.

· Make sure dimensions have not changed by measuring all lengths/widths/heights and diagonal distances.

Note: A dimensional checklist is attached to the end of this document. Please provide a copy of the completed checklist to Cal Poly for review.

· Check all solar panels to ensure that they are not protruding beyond the specified allowance described in the dimensional checklist.
· Examine all deployables. Ensure that they are firmly attached and in the dimensional tolerance described in the dimensional checklist.
· Check for sharp edges or protruding objects that could get caught.
· Check for any loose wires or dangling components.
· Check all fasteners and make sure they are still tight and staking compound is intact, if staking compound is applied.

2 Thermal Vacuum Compliance

Thermal-vacuum bakeouts are critical in assemblies of space flight hardware to ensure the lowest levels of outgassing. Thermal bakeout of smaller subassemblies and components help reduce overall bake time and decrease the final levels of outgassing. A minimum vacuum level of 5×10^{-4} Torr must be attained to observe the outgassing of components.

Note: NASA certified materials should always be used in space flight hardware, especially epoxies and glue. If in doubt about the materials you are using, please contact the CubeSat Coordinator. **Thermal-vacuum bakeout must be performed on fully integrated flight CubeSats before integration into the P-POD.**

2.1 How to Test

2.1.1 Please read and understand all steps before performing any actions.

2.1.2 Clean the external surface of all hardware with lint free wipes and lab grade isopropyl alcohol before inserting the hardware into the thermal-vacuum chamber.

2.1.3 Place the clean hardware into the thermal-vacuum chamber.

2.1.4 Bring the chamber to a vacuum level of at least 5×10^{-4} Torr. Outgassing will be easily observed at higher vacuum levels.

2.1.5 Record the initial pressure level and temperature in the Bakeout Compliance Checklist attached at the end of this document.

2.1.6 Starting at room temperature, approximately 25°C, raise the temperature of the shroud or heating element to 70°C.

2.1.7 As temperature is increasing, record the pressure level along with the corresponding temperature every 20 minutes.

2.1.8 Wait until the exterior surface of the hardware has reached 70°C. Note: There maybe an initial increase in pressure, this is to be expected.

2.1.9 Let the hardware bake at 70°C for one hour.

2.1.10 Record the temperature and pressure every 10 minutes during this first bake, making note of any unusual pressure readings.

2.1.11 If you do not wish to bring your flight hardware to 70°C, you may set the upper temperature extreme to 60°C. However, you must let the hardware bake for two hours.

2.1.12 Bring the chamber and hardware back to room temperature.

2.1.13 As temperature is decreasing, record the pressure and temperature every 20 minutes.

2.1.14 Keep the shroud and hardware at room temperature for one hour.

2.1.15 Record the pressure and temperature every 20 minutes.

2.1.16 Bring the shroud and hardware back up to 70°C for the final bakeout.

2.1.17 As the temperature increases, record the pressure and temperature every 20 minutes.

2.1.18 Let the hardware bake for one hour at 70°C.

2.1.19 Record the pressure and temperature every 10 minutes.

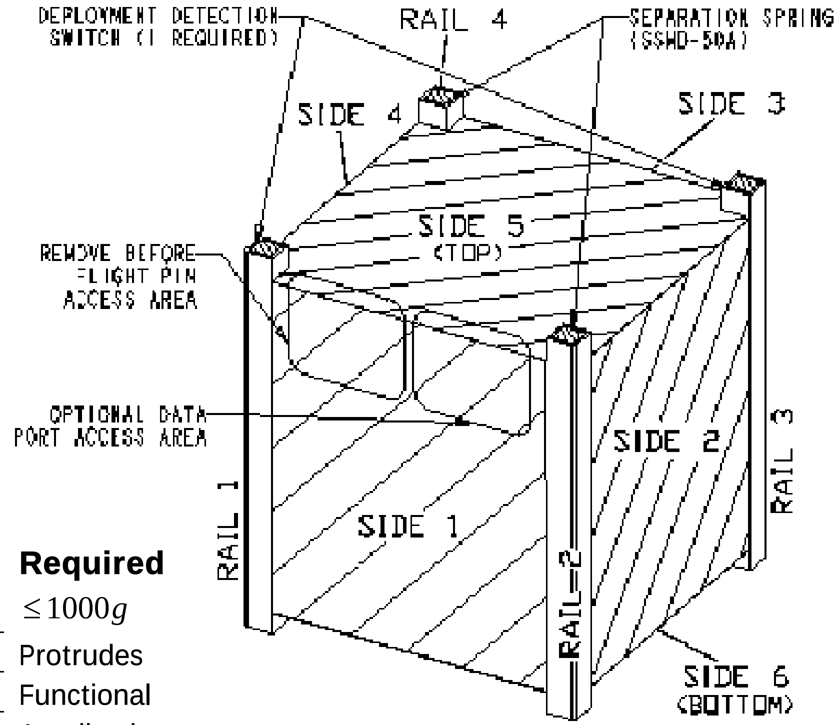
2.1.20 If you do not wish to bring your flight hardware to 70°C, you may set the upper temperature extreme to 60°C. However, you must let the hardware bake for two hours.

This will eliminate most of the outgassing that will occur at this temperature extreme. The pressure should remain constant and should not exceed $+ 1 \times 10^{-4}$ Torr from the original pressure at room temperature. If the pressure does increase, longer thermal baking is needed until the pressure stabilizes. The shroud and hardware are now brought back to room temperature.

2.1.21 Thermal bakeout is now complete.

Appendix 1

Cubesat Acceptance Checklist



Revision Date: April 4, 2004
Author: Armen Toorian

This document is intended to be used concurrently with the Cubesat Integration Procedure (CIP)

List Item	Actual	Required
Mass	____________	$\leq 1000g$
Remove Before Flight	____________	Protrudes
Spring Plungers	____________	Functional
Rails	____________	Anodized
Deployment Switches	____________	Functional

Authorized By:

IT #1: ____________

IT #2: ____________

Width [x-y]

Side 1	____________	$100.0 \pm 0.1mm$
Side 2	____________	$100.0 \pm 0.1mm$
Side 3	____________	$100.0 \pm 0.1mm$
Side 4	____________	$100.0 \pm 0.1mm$

Testing Info:

Date: ____________

Passed: **Y / N**

Height [z]

Rail 1	____________	$113.5 \pm 0.1mm$
Rail 2	____________	$113.5 \pm 0.1mm$
Rail 3	____________	$113.5 \pm 0.1mm$
Rail 4	____________	$113.5 \pm 0.1mm$

Diagonal [x-y]

Top 1&3	____________	$141.2^{+0}_{-1.5}mm$
Top 2&4	____________	$141.2^{+0}_{-1.5}mm$
Bottom 1&3	____________	$141.2^{+0}_{-1.5}mm$
Bottom 2&4	____________	$141.2^{+0}_{-1.5}mm$

Appendix 2
Vibration Compliance Checklist

Revision Date: Aug. 5, 2004
Author: Armen Toorian

ORGANIZATION NAME:

TEST NAME					
DATE		LOCATION			
TEST SETUP	MAX LEVELS		DURATION		
RESULTS / PROBLEMS			PASS ☐	FAIL ☐	
TEST DATA LOCATION					
TEST ENGINEER(S):					
SIGNATURE(S):					

Appendix 3
Bakeout Compliance Checklist

Revision Date: Aug. 5, 2004
Author: Roland Coelho

ORGANIZATION NAME:

Test Hardware				
Date		Location		
Initial Temperature			Initial Pressure	

Temperature: 1st Ramp Increase	Corresponding Pressure	Comments

Temperature: 1st Hot Soak	Corresponding Pressure	Comments

Temperature: 1st Ramp Decrease	Corresponding Pressure	Comments

Temperature: Room Temp. Soak	Corresponding Pressure	Comments

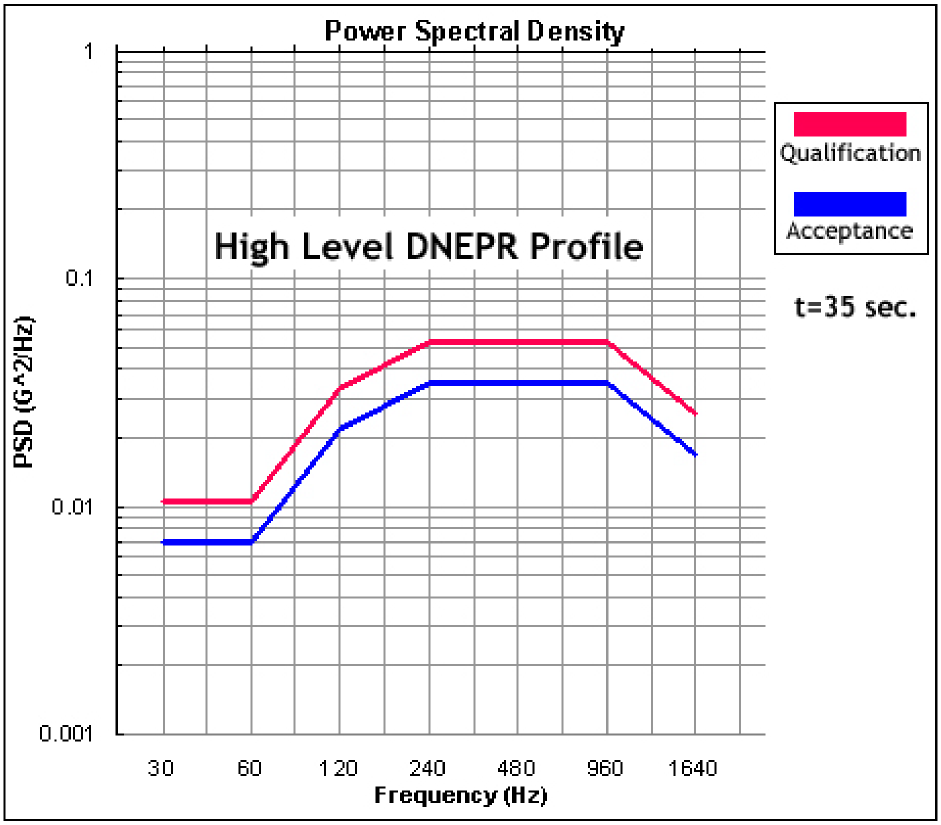
Temperature: 2nd Ramp Increase	Corresponding Pressure	Comments

Temperature: 2nd Hot Soak	Corresponding Pressure	Comments

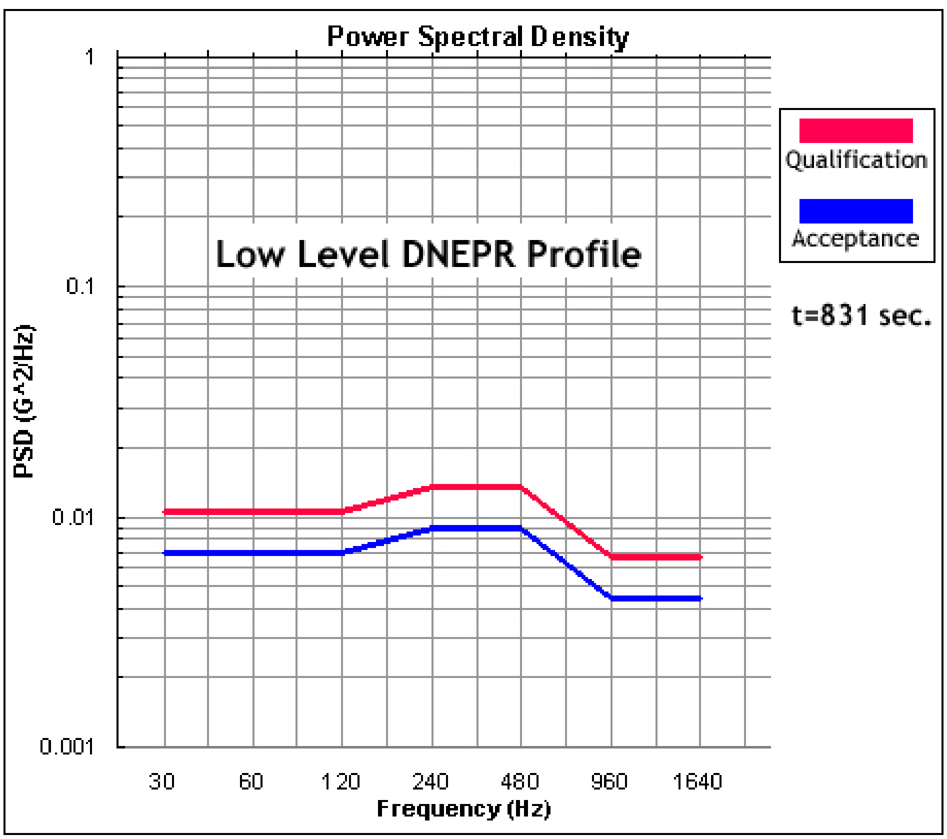
Temperature: 2nd Ramp Decrease	Corresponding Pressure	Comments

Results / Problems		PASS ☐ FAIL ☐
Test Engineer(s):		
Signature(s):		

Appendix 4

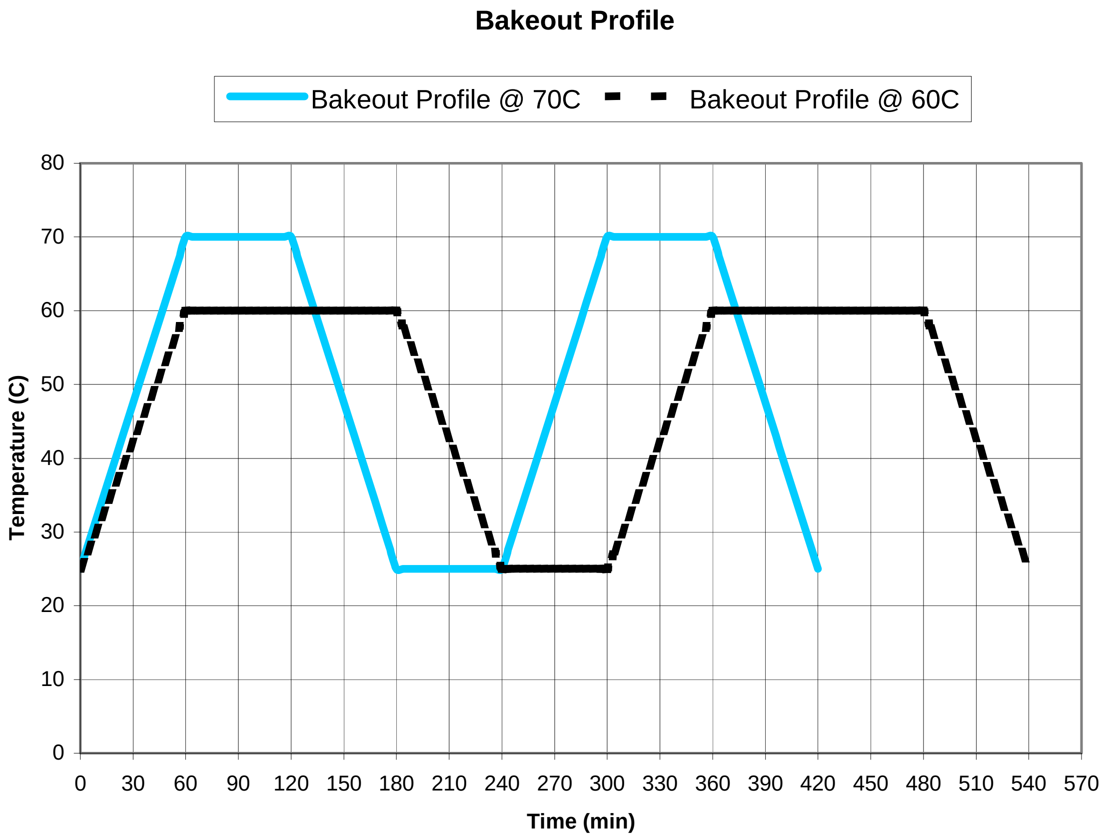


Power Spectral Density
High Level DNEPR Profile
Qualification
Acceptance
t=35 sec.
PSD (G^2/Hz)
1
0.1
0.01
0.001
30
60
120
240
480
960
1640
Frequency (Hz)



Power Spectral Density
Low Level DNEPR Profile
Qualification
Acceptance
t=831 sec.
PSD (G^2/Hz)
1
0.1
0.01
0.001
30
60
120
240
480
960
1640
Frequency (Hz)

Appendix 5



Note: The temperature ramp rates in this bakeout profile are general. Your temperature ramp rates will vary. However, the constant temperature soaks at the upper temperature extreme and at room temperature must be performed.