# Cansat 2016 Environmental Testing Requirements

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#### 1.0 Introduction

This document describes how to construct the needed fixtures and test equipment to perform environmental testing on the CanSat. The purpose of these tests is to make sure the CanSat survives the launch, deployment, and landing.

Three tests are to be conducted to test the recovery system of the container, the release mechanism for releasing the CanSat from the container, Construction quality and material performance.

# 2.0 Drop Test

This test is designed to verify that the container parachute and attachment point will survive the deployment from the rocket payload section which can be very violent. The release mechanism will also be tested to verify it can hold the science vehicle in the container. Component mounts and battery mount will also be tested. The drop test generates about 48 Gs of shock to the system.

# 2.1 Drop Test Configuration

This test requires a non-stretching cord. The test was developed with a 1/8 thick kevlar cord. One end was secured to the ceiling using an eye-bolt attachment. The other end was tied to the parachute. The length of the cord is adjusted so that the CanSat does not reach the ground when fully suspended. A floor mat or pillow may be placed under the CanSat for the drop test.

A structure can also be built is securing the cord to the ceiling is not possible. The structure must not flex during the drop test. 80/20 or a wood structure will suffice.

## 2.2 Drop Test Procedure

- 1. Secure the cord to the ceiling or structure eye-bolt.
- 2. Secure the other end of the cord to the parachute attachment point of the container.
- 3. Raise the CanSat up 80 cm in line with the cord.
- 4. Release the CanSat and let it drop.
- 5. Observe the results of the drop test. Did the parachute attachment point fail? Did the science vehicle release from the container.
- 6. Remove the science vehicle from the container and inspect for any damage.
- 7. If there was no damage, turn on the science vehicle and perform a functional test.

#### 3.0 Vibration Test

This test is designed to verify the workmanship of the science vehicle and the container if the container includes any mechanisms and/or electronics. This test will verify the mounting integrity of all components, battery connections, etc. The test uses an orbit sander. The sander is a hand held power tool where the sanding head moves in a circular pattern. Some of the more expensive sanders can do random patterns. That is not necessary. Orbit sanders operate at a fixed orbits per minute (opm) ranging from 12,000 to 14,000 opm. That translates to 200 to 233 Hz. This test takes advantage of the power up and power down phases of the sander. The sander does not instantly turn on at 14,000 opm, it takes at most a second to get up to speed. That transition time can hit some resonances of the CanSat. This test requires the sander to be cycled regularly over a one minute duration exposing the CanSat to vibrations from 0 Hz to 233 Hz. The amount of shaking generated by the sander is around 20 to 29 Gs.

## 3.1 Vibration Test Configuration

This test requires the following materials:

- 1. Orbit sander
- 2. Power strip with power switch
- 3. A large benchtop vise
- 4. Duct tape and or other method of securing the CanSat to the orbit sander
- 5. Optional but recommended: 3 axis (50+ Gs) accelerometer mounted to test fixture
- 6. Optional but recommended: 3 axis (50+ Gs) accelerometer mounted somewhere on CanSat.
- 7. Optional but recommended: A system to capture accelerometer data 500 Hz or as fast as possible.

#### Set up is as follows:

- 1. Turn the power switch of the sander to the on position while it is not plugged in.
- 2. Turn the sander upside down and secure it in the bench vise.
- 3. With the power switch on the power strip in the off position, plug the sander into the power strip and the power strip into the local mains.
- 4. Secure the CanSat on the sander, the part where sand paper is installed.

#### 3.2 Vibration Procedure

- 1. Perform a functional test of the CanSat.
- 2. Mount the science vehicle on the vibration fixture and secure it in place.
- 3. If included, start the accelerometer data collection.
- 4. Over a 1 minute period, turn the sander on. Let it power up to full speed, wait 2 seconds and turn off. As soon as the sander stops moving, repeat until one minute is complete.

- 5. Remove CanSat from test fixture and inspect it for any damage.
- 6. Perform a functional test.
- 7. Review accelerometer data to determine the intensity of the vibrations.

#### 4.0 Thermal Test

This test is to verify the CanSat and container can operate in a hot environment. When the CanSat is integrated into the rocket and sitting on the launch pad, the sun can heat up the payload section of the rocket. Temperatures in the mid to upper 30C have been recorded. This test will also determine if any materials warp, weaken, or change characteristics. It is up to the team to determine what tests to perform to verify material integrity and performance.

## 4.1 Test Configuration

There are a few ways to build a thermal chamber. The simplest is to acquire an insulating cooler, one or more hair dryers and a thermometer, preferably a remote thermometer such as a thermocouple or thermistor.

Place the CanSat, hair dryer(s) and thermometer in the cooler. Try to seal any openings. Make sure the hair dryer does not blow directly on the CanSat. The hair dryer will circulate and heat the air in the cooler.

Another method is to build a thermal chamber with foam insulation sheets. Select the sheets that have one side with a foil layer. Build a box and have one side be a lid. Seal all edges with duct tape. You can make a hole in the side to run cords and thermocouple through.

It is highly suggested the thermistor or thermocouple be attached to the CanSat. The purpose is to make sure the CanSat does reach the peak temperature. The air will reach the peak temperature long before the CanSat does. Multiple sensors can be placed on various parts of the CanSat.

#### 4.2 Test Procedure

- 1. Place CanSat into the thermal chamber.
- 2. Turn on the CanSat.
- 3. Close and seal the thermal chamber.
- 4. Turn on the heat source.
- 5. Monitor the temperature and turn off the heat source when the internal temperature reaches 60C and turn on heat source when the temperature drops to 55C.
- 6. Maintain the temperature for two hours.
- 7. Turn off heat source and perform visual inspection and any functional tests to verify the CanSat survived the thermal exposure and can operate as expected.
- 8. With the CanSat still hot, test any mechanisms and structures to make sure the integrity has not been compromised.
- 9. Verify epoxy joints and composite materials still maintain their strengths.

#### 5.0 Fit Check

This test is to verify the CanSat will properly fit in the rocket payload section and slide out at deployment time.

## 5.1 Test Configuration

Using either a sheet of aluminum or sheet of plywood, cut a hole in the sheet with a diameter of 125.5mm. For better precision, use a CNC router or mill. The sheet of material must be at least 152 mm wide and long for rigidity. Use 1.5mm or thicker aluminum to minimize flexing or warping or 6mm thick plywood.

If using plywood, verify the whole dimension in case the wood expands or contracts due to the environment.

#### 5.2 Test Procedure

- 1. Secure the test fixture so it is rigidly held in place.
- 2. Slide the CanSat container through the hole to verify it is within the required envelope.

# **6.0 Documentation Requirements**

The testing must be documented and submitted at the Flight Readiness Review. The following is required:

- 1. A 10 second long video showing the successful drop test.
- 2. A 10 second long video showing the vibe test.
- 3. A photo showing a display indicating temperatures during the thermal testing.
- 4. A photo shoing the results of the fit check.
- 5. Completed check list on the next page.

Test	Test Description	Result
Drop Test	Does the cord for the drop test stretch?	Yes/No
Drop Test	Was the glider secured inside the container before the drop test?	Yes/No
Drop Test	Did the CanSat drop 80 cm?	Yes/No
Drop Test	Did the glider stay inside the container after the drop test?	Yes/No
Drop Test	Was there any signs of damage after the drop test?	Yes/No
Drop Test	Does the electronics still function after the drop test?	Yes/No
Drop Test	Has any components moved after the drop test?	Yes/No
Vibration Test	Is the CanSat secured to the vibration table so it cannot shift around on its own?	Yes/No
Vibration Test	After being vibrated, have any components come loose or fallen off?	Yes/No
Vibration Test	After vibration, does the electronics still function?	Yes/No
Thermal Test	Does the electronics still function at the peak temperature?	Yes/No
Thermal Test	Has any structural component weakened at the peak temperature?	Yes/No
Thermal Test	Has any adhesive softened or become unsecured at the peak temperautre?	Yes/No
Thermal Test	Has any material softened or deformed at the peak temperature?	Yes/No
Thermal Test	Has any materials required to be springy lost its springiness?	Yes/No
Fit Check	Does the container fit through the fit check jig?	Yes/No
Fit Check	Do any parts of the container get caught by the fit check jig?	Yes/No
Final Check	After all the tests, does the electronics still function properly?	Yes/No
Final Check	Do all mechanisms still function properly?	Yes/No