CanSat Competition Guide
2021

Autorotating Science Payload Relay Mission

Rev 1.0
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Revisions

Date	Changes
7/8/2020	Initial guide

1. Introduction

The CanSat competition is a design-build-fly competition that provides teams with an opportunity to experience the design life-cycle of an aerospace system. The CanSat competition is designed to reflect a typical aerospace program on a small scale and includes all aspects of an aerospace program from the preliminary design review to post mission review. The mission and its requirements are designed to reflect various aspects of real world missions including telemetry requirements, communications, and autonomous operations. Each team is scored throughout the competition on real-world deliverables such as schedules, design review presentations, and demonstration flights.

1.1 Competition Description

The competition will proceed during the global pandemic. The competition is planning to have a launch in June for teams to demonstrate their payloads. The competition is also working on alternative plans in the event travel is not allowed or the host site has to cancel the launch. If the launch is not held, remote live demonstrations of the cansat functionality will be performed in place of the launch. Other scored documentation will also be required.

To control the size of the competition, only three teams per school are allowed to apply to the competition. It is recommended that schools hold internal design competitions to determine the three teams to apply. If more than three teams from one school apply, the first three applications received will be accepted.

The competition is in five phases.

Phase one is the application phase. Teams must submit an application and a $200 competition fee that is non-refundable. The fee is used to offset the cost of rocket motors and other materials. Applications must be submitted by October 30, 2020. Payments will be requested in early November and must be paid by the given due date.

Phase two is the preliminary design. Teams are to develop designs, prototype, test concepts and generate a preliminary design review (PDR) slide package using the provided template. Teams will submit PDR slides only in PDF format at the designated due date. Teams that do not meet the due date or do not submit in the proper PDF format will be dropped from the competition. A schedule will be made available on when to present a subset of the slides. Teams will have a half hour to discuss a subset of the PDR slides via telecon.

After PDR, a total of 48 teams will be invited to the competition.

Phase three is the critical design. Teams will finalize their design and start ordering components, manufacturing parts, test subsystems and start developing the flight unit. Teams will generate a critical design review (CDR) slide package using the provided template. Teams will submit CDR slides only in PDF format at the designated due date. Teams that do

not meet the due date or do not submit in the proper PDF format will be dropped from the competition. A schedule will be made available on when to present a subset of the slides. Teams will have a half hour to discuss a subset of the CDR slides via telecon.

Phase four is the launch weekend. Friday, teams will be scheduled to present their completed CanSat for flight readiness review which must be completed in 30 minutes. The CanSat must be ready to launch at this time. It must be completely assembled and operational. Each team will be scored during the flight readiness review. Teams can only present once at the flight readiness review at their designated time. Teams late for the review will lose points. CanSats must pass the drop test, fit check, and battery verification in order to fly. Multiple attempts at the drop test are allowed.

Saturday is the launch day where teams will perform final preparations and turn in CanSats by 12:00 hours local time. Launch will start at 13:00 hours local time and continue until all launches are completed. There will be no second flights unless the fault is of the launch provider and there are spare rockets and rocket motors.

Phase five is the Post Flight Review (PFR). Post Flight Review is a 15 minute presentation of the flight results and 5 minutes for questions. Awards will be presented at the end of the post Flight Reviews.

For teams to receive certificates of accomplishment and be considered for awards, they must complete all phases of the competition.

Late submissions will not be accepted for any phase and the team will be dropped from the competition. Internet issues, file issues, email issues, and any other issues will not be considered. **Submit the documents early to be safe.**

All scoring and judging results are final. Scoring is set up to be quantitative with little qualitative scoring to minimize any biases.

The competition is operated by a dedicated group of volunteers who spend their own time supporting various phases of the competition. Some volunteers spend their own funds to attend and support the competition while others are graciously supported by their employers. The competition is designed to provide teams a great educational experience and to minimize the time of the volunteers. Strict due dates, file templates, and file name formats are required to minimize the times of the volunteers who have little time to spare. Please follow all due dates and all submission requirements to help the volunteers.

1.2 Team Selection

Team selection will be different. Since the competition is sponsored by US organizations, the competition is now required to include at minimum 20 US teams. During the application phase of the competition, up to 20 teams per country can participate. If more than 20 apply per

country, a random selection will be made for the 20 teams per country.

For the top 48 selection, 20 teams are required to be from the US. The remaining 20 teams can be from other countries. Teams from each country will be ranked only among their country. Then the top scoring teams from each country will be selected in a round robin method. The top team from each country will be selected in the first round, then the next top team from each country will be selected in the second round and the selection is repeated until 28 teams are selected. This will create the greatest diversity in teams and allow more countries to participate.

2. Mission Overview

Design a Cansat that shall consist of a container and two autorotating maple seed science payloads. The container shall contain electronics to release the autorotating maple seed science payloads and relay data from the payload to a ground station.

The Cansat shall be launched to an altitude ranging 670 meters to 725 meters above the launch site and deployed near apogee (peak altitude). Orientation of deployment is not controlled and is most definitely violent. The CanSat container must protect the science payloads from damage during the launch and deployment.

Once the CanSat is deployed from the rocket, the CanSat shall descend using a parachute at a descent rate of 15 m/s. At 500 meters, the container shall release one autorotating maple seed science payload. At 400 meters, the container shall release the second autorotating maple seed science payload. The container shall relay all telemetry sent from the science payloads until the container lands. The container shall also incorporate its own telemetry along with the autorotating maple seed science payload telemetry. The container shall transmit using the team number as its net ID.

The autorotating maple seed science payloads shall descend after being released and spin rapidly enough so its descent rate is less than 20 m/s. The science payload shall transmit telemetry once a second and include air pressure and air temperature. The science payloads shall transmit for five minutes after being released and use the team number plus 5 as its net ID.
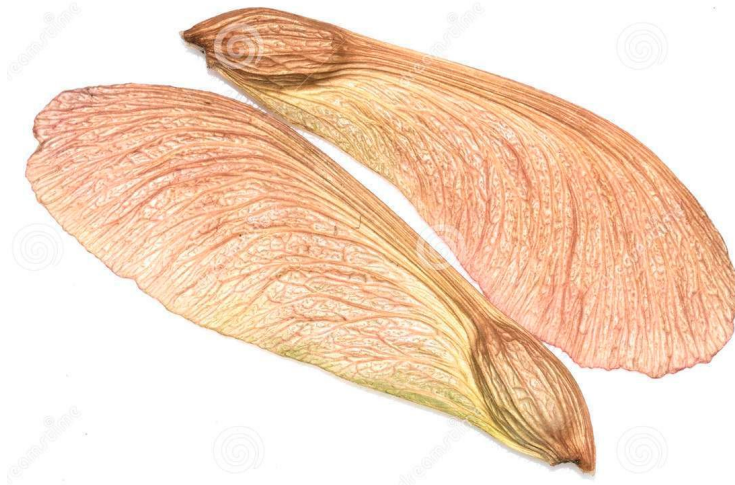
Maple Seed Example

3. Requirements

3.1 Base Requirements

Requirement Number	Requirement
1	Total mass of the CanSat (science payloads and container) shall be 600 grams +/- 10 grams.
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 400 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.
4	The container shall be a fluorescent color; pink, red or orange.
5	The container shall be solid and fully enclose the science payloads. Small holes to allow access to turn on the science payloads is allowed. The end of the container where the payload deploys may be open.
6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.
7	The rocket airframe shall not be used as part of the CanSat operations.
8	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.

9	The Parachutes shall be fluorescent Pink or Orange
10	The descent rate of the CanSat (container and science payload) shall be 15 meters/second +/- 5m/s.
11	All structures shall be built to survive 15 Gs of launch acceleration.
12	All structures shall be built to survive 30 Gs of shock.
13	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.
14	All mechanisms shall be capable of maintaining their configuration or states under all forces.
15	Mechanisms shall not use pyrotechnics or chemicals.
16	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.
17	Both the container and payloads shall be labeled with team contact information including email address.
18	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.
19	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.
20	XBEE radios shall have their NETID/PANID set to their team number.
21	XBEE radios shall not use broadcast mode.
22	The science payload shall descend spinning passively like a maple seed with no propulsion.
23	The science payload shall have a maximum descent rate of 20 m/s.
24	The wing of the science payload shall be colored fluorescent orange, pink or green.
25	The science payload shall measure altitude using an air pressure sensor.
26	The science payload shall measure air temperature.
27	The science payload shall measure rotation rate as it descends.
28	The science payload shall transmit all sensor data once per second.
29	The science payload telemetry shall be transmitted to the container only.
30	The science payload shall have their NETID/PANID set to their team number plus five. If team number is 1000, sensor payload NETID is 1005.
31	The container shall include electronics to receive sensor payload telemetry.
32	The container shall include electronics and mechanisms to release the

		science payloads.
33	The container shall include a GPS sensor to track its position.	
34	The container shall include a pressure sensor to measure altitude.	
35	The container shall measure its battery voltage.	
36	The container shall transmit its telemetry and the payload telemetry received once per second in the format described in the Telemetry Requirements section.	
37	The container shall stop transmitting telemetry when it lands.	
38	The container and science payloads must include an easily accessible power switch that can be accessed without disassembling the cansat and science payloads and in the stowed configuration.	
39	The container must include a power indicator such as an LED or sound generating device that can be easily seen or heard without disassembling the cansat and in the stowed state.	
40	An audio beacon is required for the container. It may be powered after landing or operate continuously.	
41	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	
42	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.	
44	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	
45	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	
46	The Cansat must operate during the environmental tests laid out in Section 3.5.	
47	The Cansat shall operate for a minimum of two hours when integrated into the rocket.	
48	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	
49	The container must maintain mission time throughout the whole mission even with processor resets or momentary power loss.	
50	The container shall have its time set to UTC time to within one second before launch.	

51	The container flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.
52	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the container altitude.
53	The container flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.
54	The ground station shall command the Cansat to start transmitting telemetry prior to launch.
55	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.
56	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.
57	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.
58	Each team shall develop their own ground station.
59	All telemetry shall be displayed in real time during descent on the ground station.
60	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)
61	Teams shall plot each telemetry data field in real time during flight.
62	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.
63	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.
64	The ground station software shall be able to command the container to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.
65	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the container.
66	The science payloads shall not transmit telemetry during the launch, and the container shall command the science payloads to begin telemetry transmission upon release from the container.

3.2 Selectable Bonus Objective

A video camera shall be integrated into the container and point toward the ground. The camera shall capture the release of both science payloads and capture the descent of the science payloads. The video shall be spin stabilized with the view not rotating more than +/- 30 degrees. Video shall be in color with a minimum resolution of 640x480 pixels and 30 frames per second. The video shall be recorded and retrieved when the container is retrieved.

3.3 Telemetry, Command, and Simulation Requirements

3.3.1 Telemetry

Upon receipt of the telemetry activation command (CX ON), the CanSat Container shall collect the required telemetry at a one Hz sample rate, and transmit the telemetry data in the ASCII format shown below. Each telemetry field is delimited by a comma, and each telemetry transmission is concluded by a carriage return character.

In addition, each Science Payload shall transmit telemetry data to the Container for relay to the ground station. The transmission format of data between the Science Payloads and the Container may be defined by the teams and will not be inspected; however, the transmission rate for Science Payload to Container is also 1Hz. Transmissions do not need to be synchronized.

3.3.1.1 Telemetry Formats

Container telemetry format (1 Hz transmission rate):

> <TEAM_ID>,<MISSION_TIME>,<PACKET_COUNT>,<PACKET_TYPE>,<MODE>,
> <SP1_RELEASED>,<SP2_RELEASED>,<ALTITUDE>,<TEMP>,
> <VOLTAGE>,<GPS_TIME>,<GPS_LATITUDE>,<GPS_LONGITUDE>,
> <GPS_ALTITUDE>,<GPS_SATS>,<SOFTWARE_STATE>,
> <SP1_PACKET_COUNT>,<SP2_PACKET_COUNT>,<CMD_ECHO>

The Container shall relay the received Science Payload data as it is received, in the following format:

> <TEAM_ID>,<MISSION_TIME>,<PACKET_COUNT>,<PACKET_TYPE>,
> <SP_ALTITUDE>,<SP_TEMP>,<SP_ROTATION_RATE>

The first four telemetry fields are common to both the Container and Science Payload telemetry and are defined as follows:

1. <TEAM_ID> is the assigned team identification.

2. <MISSION_TIME> is UTC time in format hh:mm:ss, where hh is hours, mm is minutes, and ss is seconds.

3. <PACKET_COUNT> is the count of transmitted packets, which is to be maintained through processor reset. One count is used for transmission of all packets, regardless of type.

4. <PACKET_TYPE> is the ASCII character 'C' for Container telemetry, characters 'S1'

for Science Payload 1 (deployed first) relayed telemetry, and characters 'S2' for Science Payload 2 (deployed second) relayed telemetry.

The remaining fields for the Container telemetry are defined as follows:

5. <MODE> = 'F' for flight (the default mode upon system start) and 'S' for simulation
6. <SP1_RELEASED> = 'N' for not released and 'R' for released
7. <SP2_RELEASED> = 'N' for not released and 'R' for released
8. <ALTITUDE> is the altitude in units of meters and must be relative to ground level. The resolution must be 0.1 meters.
9. <TEMP> is the temperature in degrees Celsius with a resolution of 0.1 degrees C.
10. <VOLTAGE> is the voltage of the CanSat power bus. The resolution must be 0.01 volts.
11. <GPS_TIME> is the time generated by the GPS receiver. The time must be reported in UTC and have a resolution of a second.
12. <GPS_LATITUDE> is the latitude generated by the GPS receiver in decimal degrees with a resolution of 0.0001 degrees.
13. <GPS_LONGITUDE> is the longitude generated by the GPS receiver in decimal degrees with a resolution of 0.0001 degrees.
14. <GPS_ALTITUDE> is the altitude generated by the GPS receiver in meters above mean sea level with a resolution of 0.1 meters.
15. <GPS_SATS> is the number of GPS satellites being tracked by the GPS receiver. This must be an integer number.
16. <SOFTWARE STATE> is the operating state of the software. (e.g., LAUNCH_WAIT, ASCENT, ROCKET_SEPARATION, DESCENT, SP1_RELEASE, SP2_RELEASE, LANDED, etc.)
17. <SP1_PACKET_COUNT> is the count of relayed telemetry packets from Science Payload 1
18. ,<SP2_PACKET_COUNT> is the count of relayed telemetry packets from Science Payload 2
19. <CMD_ECHO> is the fixed text command id and argument of the last received command with no commas. For example, CXON or SP101325. See the command section for details of command formats.
20. Additional comma delimited data fields may be appended after the required fields as determined necessary by the team's design

The remaining telemetry fields for the Science Payload are defined as follows:

21. <SP_ALTITUDE> is the altitude in units of meters and must be relative to ground level. The resolution must be 0.1 meters.
22. <SP_TEMP> is the measured temperature in degrees Celsius with a resolution of 0.1

degrees C.

23. <SP_ROTATION_RATE> is the science payload rotation rate around the axis perpendicular to the center of the rotor in rotations per minute (RPM).

3.3.1.2 Telemetry Data Files

The received telemetry for the entire mission shall be saved on the ground station computer as comma separated value (.csv) files that will be examined by the competition judges in Excel. The ground station shall sort telemetry packets into separate files based on the PACKET_TYPE field.

Teams shall provide the files to the judges immediately after the launch operations via USB drive.

The csv files shall include headers specifying each field of data on the first row of text in the file.

The telemetry data files shall be named as follows:

- Flight_<TEAM_ID>_C.csv for the Container Telemetry,
- Flight_<TEAM_ID>_SP1.csv for Science Payload 1, and
- Flight_<TEAM_ID>_SP2.csv for Science Payload 2.

where the team_id is the four digit team id number. For example: Flight_1000_C.csv, Flight_1000_S1.csv, and Flight_1000_S2.csv are the required file names for imaginary team 1000.

The ground software shall produce the files, with the correct name, easily from the ground system user interface.

3.3.2.3 On-board Telemetry Storage

It is suggested that teams make use of onboard data storage as backup in case of radio failure. Only the transmitted telemetry is graded on flight day; however, the backup data can be used when completing the Post Flight Review.

3.3.2 Commands

The Container shall receive and process the following commands from the Ground Station:

CX - Container Telemetry On/Off Command

CMD,<TEAM_ID>,CX,<ON_OFF>

Where:

1. CMD and CX are static text.
2. <TEAM ID> is the assigned team identification.
3. <ON_OFF> is the string 'ON' to activate the Container telemetry transmissions and 'OFF' to turn off the transmissions.

Example: The command CMD,1000,CX,ON activates Container telemetry

transmission, assuming the team id is 1000.

ST - Set Time

CMD,<TEAM_ID>,ST,<UTC_TIME>

Where:

4. CMD and ST are static text.
5. <TEAM ID> is the assigned team identification.
6. <UTC_TIME> is UTC time in the format hh:mm:ss where hh is hours, mm is the minutes and ss is the seconds.

Example: The command CMD,1000,ST,13:35:59 sets the mission time to the value given.

It is recommended that the time be set directly from the Ground System time, in UTC, rather than being typed into the command manually.

SIM - Simulation Mode Control Command

CMD,<TEAM_ID>,SIM,<MODE>

Where:

1. CMD and SIM are static text.
2. <TEAM_ID> is the assigned team identification.
3. <MODE> is the string 'ENABLE' to enable the simulation mode, 'ACTIVATE' to activate the simulation mode, or 'DISABLE' which both disables and deactivates the simulation mode.

Example: Both the CMD,1000,SIM,ENABLE and CMD,1000,SIM,ACTIVATE commands are required to begin simulation mode.

PX - Science Payload Transmission On/Off

CMD,<TEAM_ID>,SP1X,<ON_OFF>
CMD,<TEAM_ID>,SP2X,<ON_OFF>

Where:

1. CMD is static text
2. SP1X and SP2X are static text indicating to control telemetry for SP1 and SP2, respectively
3. <TEAM ID> is the assigned team identification.
4. <ON_OFF> is the string 'ON' to activate the Science Payload transmissions and

'OFF' to turn off the transmissions

Example: CMD,1000,SP1X,ON will trigger the Container to relay a command to the Science Payload 1 to begin telemetry transmissions.

SIMP - Simulated Pressure Data (to be used in Simulation Mode only)

CMD,<TEAM ID>,SIMP,<PRESSURE>

Where:

1. CMD and SIMP are static text.
2. <TEAM ID> is the assigned team identification.
3. <PRESSURE> is the simulated atmospheric pressure data in units of pascals with a resolution of one Pascal.

Example: CMD,1000,SIMP,101325 provides a simulated pressure reading to the Container (101325 Pascals = approximately sea level). Note: this command is to be used only in simulation mode.

Other commands are allowed and suggested (e.g., manual release of Science Payloads) as determined necessary by the team.

The format of command data between the Container and the Science Payloads is to be designed by the students and will not be reviewed as part of the competition.

3.3.3 Simulation Mode

The Cansat Container shall operate in two modes:
- FLIGHT mode where the Container operates as described in the Mission Overview section using actual sensor data, and
- SIMULATION mode where the Container receives simulated barometric pressure values from the Ground Station via commands and substitutes those values for the actual pressure sensor reading for calculation of altitude and for use by the flight software logic.

Simulation Mode does not affect Container sensor data other than the barometric pressure sensor or the operation of the Science Payloads. In Simulation Mode, the telemetered pressure sensor data should reflect the commanded simulation values, not the actual sensor readings.

The team's Ground Station shall have the capability to read a .csv file of barometric pressure data that simulates the mission profile and transmit the values via commands to the Container

at a rate of one per second. The pressure profile data file will be provided by the competition judges, and may vary between teams.

Simulation Mode Concept of Operation

For testing, pre-flight demonstration, and in a contingency where launch operations are not possible, a profile of barometric pressure data that represents the expected flight profile can be transmitted by the team's Ground System at a rate of one sample per second. Upon receipt, the flight software will substitute the received value for the actual pressure sensor reading.

Container telemetry operates the same in FLIGHT and SIMULATION mode. So, the values, other than the pressure and altitude (calculated from the pressure values) will be actual sensor readings (e.g., actual battery, temperature, and GPS). The relayed Science Payload telemetry shall contain actual sensor values, also.

Because accidental initiation of SIMULATION mode can endanger the flight mission, two commands, SIM ENABLE and SIM ACTIVATE, must be received by the flight software before Simulation mode is activated.

After activation, the flight software monitors the radio link for barometric pressure sensor commands (SIMP) from the Ground Station and uses the received values as if they were actual barometric pressure readings in the calculation of altitude, determination software state, and when to release the Sensor Payloads.

3.4 Banned Materials and components

1. No foam based beads or other similar bits of foam material that can be dropped and lost on the ground. This material is dangerous to the livestock that occupy this area.
2. No lithium polymer batteries. The battery is relatively easy to damage and a fire hazard. We want to avoid setting any parts of the field on fire.

3.5 Environmental Tests

Four 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. To verify test results, teams should provide: 1) Environmental Test Document

based on the provided template file. 2) Videos of the tests performed as specified in the template document.

1. 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 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 30 Gs of shock to the system.
    a. Drop Test Description - This test requires a 61 cm non-stretching cord. The test was developed with a 1/8 thick kevlar cord. One end is secured to an eyebolt attached to a fixed point, such as ceiling or rigid structure with enough clearance to accommodate the cord, CANSAT, and free space so the cansat does not hit the ground. The other end is tied to the parachute. A floor mat or pillow may be placed under the CanSat for the drop test.. The structure must not flex during the drop test.
    b. Drop Test Procedure -
        i. Power on CanSat.
        ii. Verify telemetry is being received.
        iii. Raise CanSat by the attached cord, so that the attachment points of the cord, on the eye bolt and the parachute, are at the same height.
        iv. Release the CanSat.
        v. Verify the CanSat did not lose power.
        vi. Inspect for any damage, or detached parts.
        vii. Verify telemetry is still being received.
2. 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 to temperatures up to the mid to upper 30C. This test will determine if any materials warp, weaken, change characteristics, or fail to function at temperatures up to 35C.
    a. Thermal Test Description - This test requires a method to heat the CanSat to 60C for a period of 2 hours. This will allow the components to rise to heat, and verify that they continue to function. One way to heat the CanSat is a thermal chamber; there are a few ways to build a thermal chamber.
        i. 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.

ii. 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.

iii. 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.

b. Thermal Test Procedure -
   i. Place CanSat into a thermal chamber.
   ii. Turn on the CanSat.
   iii. Close and seal the thermal chamber.
   iv. Turn on the heat source.
   v. Monitor the temperature and turn off the heat source when the internal temperature reaches 60C and turn on the heat source when the temperature drops to 55C.
   vi. Maintain the test conditions for two hours.
   vii. Turn off the heat source and perform visual inspection and any functional tests to verify the CanSat survived the thermal exposure and can operate as expected.
   viii. With the CanSat still hot, test any mechanisms and structures to make sure the integrity has not been compromised. Take precautions to avoid injury.
   ix. Verify epoxy joints and composite materials still maintain their strengths.

3. **Vibration Test** - This test is designed to verify the mounting integrity of all components, mounting connections, structural integrity, and battery connections.

a. Vibration Test Description - The test uses an orbit sander. The sander is a hand held power tool where the sanding head moves in a random pattern, not spinning. 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.

   i. One setup for the test is to secure the sander, upside down, via a bench vise; the CanSat should be secured where the sand-paper is installed.

b. Vibration Test Procedure -

     i.   Power on the CanSat.

     ii.   Verify accelerometer data is being collected.

     iii.   Power up the sander.

     iv.   Once the sander is up to full speed, wait 5 seconds.

     v.   Power down the sander to a full stop.

     vi.   Repeat steps iii to v four more times.

     vii.   Inspect the CanSat for damage and functionality.

     viii.   Verify accelerometer data is still being collected.

     ix.   Power down CanSat.

4. Vacuum Test - This test is designed to verify deployment operation of the payload(s). A vacuum chamber can be simply constructed using a bucket or pail of 5 gallons or 18+ litres. A lid can be used or a ¼ inch or 6 mm thick sheet of polycarbonate can be placed on top of the bucket. Do not use acrylic as that can shatter. A vacuum cleaner or shop vacuum can be used to pull a vacuum.

     i.   Suspend the fully configured and powered CanSat in the vacuum chamber.

     ii.   Turn on the vacuum to start pulling a vacuum.

     iii.   Monitor the telemetry and stop the vacuum when the peak altitude has been reached.

     iv.   Let the air enter the vacuum chamber slowly and monitor the operation of the CanSat.

     v.   Collect and save telemetry

3.6 COVID-19 Safety Plan

Since we are all dealing with the pandemic, it will be wise to develop a safety plan and operation protocols to protect team members, faculty, other students and family. Many companies had to develop safety protocols to bring their employees back to facilities and minimize the chance of spreading the virus. Many companies and government agencies are allowing employees to telework as much as possible and only enter facilities when needed. At the facilities, employers require employees to wear protection, maintain distances, restrict movement through the facilities, reduce the number of people in any part of the facilities and have cleaning procedures. One example related to building products that require multiple people is that one person performs their function and leaves to let the next person work on the product with cleaning performed between people. It does slow progress but lives are more important.

4. Team Composition

Students currently enrolled in undergraduate degree programs, or students having graduated from such programs since the start of the current competition cycle, are counted as undergraduate students.

Students currently enrolled in post-graduate degree programs (MS, PhD), or students having entered such programs since the start of the current competition cycle, are counted as graduate students.

4.1 Team Size

Each team shall consist of between 3 and 10 students (undergraduate teams) from an accredited college or university. Teams may consist entirely of undergraduate students (undergraduate teams), entirely of graduate students (grad teams), or a combination of the two (mixed teams). Graduate teams shall consist of no more than 5 students. Mixed teams shall consist of no more than 7 undergraduate students and 3 graduate students.

Teams from the same school must develop their designs independently and **not** copy from other teams. Bulk purchasing of materials is allowed such as batteries and raw materials for construction. Sharing tools and services are allowed. Designs must originate from within the team.

There shall be no more than three teams from any one school.

4.2 Faculty Advisor

Each team must have a faculty advisor. The role of the faculty advisor is to:
- Provide a point of contact for the team, both with the university and the competition.
- Aid teams with logistics such as arranging conference rooms, laboratory resources, etc.
- Providing general guidance throughout the competition.

The faculty advisor shall not:
- Make design decisions or direct recommendations.
- Participate in more than an oversight role during reviews.

5. Deliverable Items

Teams will be evaluated based on a series of deliverable items provided at various stages of the development. The deliverable items are selected to provide representative real-world milestones for tracking the CanSat development and ensuring team success.

5.1 Preliminary Design Review

The PDR is a "multi-disciplinary technical review to ensure that the system under review can proceed into detailed design, and can meet the stated performance requirements within cost (program budget), schedule (program schedule), risk, and other system constraints". The CanSat PDR shall demonstrate:

- An understanding of the CanSat mission requirements
- Allocation and derivation of system and subsystem requirements
- Definition of the CanSat concept of operations
- Overview of preliminary design that meets specified requirements
- Results of, or identification of, necessary trades to support preliminary design. While it is ideal to have completed trades prior to the preliminary design, it is not necessary.
- Results of, or identification of, necessary prototyping or testing efforts necessary to support or finalize the preliminary design.
- Preliminary budget
- Detailed development schedule

Preliminary design reviews shall be conducted via teleconference coordinated by the team lead(s). The PDR presentations shall be less than 30 minutes in duration including time for questions. Presentation reviewers shall be permitted to ask questions during the presentation (i.e., questions are not held until the end of the presentation).

The PDR shall follow the presentation template posted on the CanSat Competition website.

5.2 Critical Design Review

The CDR is "a multi-disciplined technical review to ensure that the system under review can proceed into system fabrication, demonstration, and test; and can meet the stated performance requirements within cost (program budget), schedule (program schedule), risk, and other system constraints". The CDR shall demonstrate:

- All PDR level requirement TBDs and TBRs shall be resolved
- Refinement of the CanSat CONOP
- Results of detailed design and analysis for each subsystem
- Verification that detailed design meets system and subsystem level requirements
- Identification of subsystem and system level tests necessary for requirements verification
- Results of requirements verification tests completed to date
- Overview of mission operations
- Preliminary launch day sequence of events
- Revised budget

- Updated development schedule

Critical design reviews shall be conducted via teleconference coordinated by the team lead(s). The CDR presentations shall be less than 30 minutes in duration including time for questions. Presentation reviewers shall be permitted to ask questions during the presentation (i.e., questions are not held until the end of the presentation).

The CDR shall follow the presentation template specified in the "CanSat CDR Outline" document available on the CanSat Competition website. Extra material in the form of backup slides is permitted.

Each section of the CDR shall be scored in accordance with the values listed in the outline. The CDR shall contribute to the total evaluation of the CanSat design according to the values listed the section Evaluation and Scoring.

5.3 Post Flight Review

The PFR provides an assessment of flight operations and results of the demonstration flight. The PFR provides an assessment of successful and unsuccessful flight operations. The PFR shall provide:

- Overview of mission objectives and CanSat design
- Comparison of planned and actual CONOPS and SOE
- Raw and processed data from flight operations
- Failure analysis and assessment (for unsuccessful mission objectives)

Post Flight Reviews shall be conducted the day following the demonstration flight activities, unless flight operations are canceled due to weather. Presentations shall be limited to 20 minutes, including questions.

Each section of the PFR shall be scored in accordance with the values listed in the outline. The PFR shall contribute to the total evaluation of the CanSat design according to the values listed in the section Evaluation and Scoring.

Post Flight Review presentations shall be submitted by 8:45 AM to the judges. There will be two presentation rooms. Teams will be preassigned to the presentation room. Late submissions will lose points. Each team will be given a thumb drive. Teams are to install their PFR slides on the thumb drive and deliver the thumb drive to the designated location between 8 AM and 8:45 AM Sunday. Teams delivering after 8:45 AM will lose points. This is done to make sure all teams have the same amount of time to prepare for PFR.

5.4 Deliverable Submissions and Scheduling

All deliverable items shall be submitted to the competition email by the dates listed in Table 1.

All deliverable items shall be submitted in PDF format using the naming convention listed in Table 1 where # corresponds to the assigned team number for each team and v# is a unique revision number for the review package that can be used to track revisions. For example, a submission for imaginary team number 1000 of version 2 of the PDR package would be named `cansat2021_1000_pdr_v02.pdf`. Note that adherence to the filename and format specification is scored during the competition.

If you resubmit your presentation, you must increment the version number otherwise the previous version may be used. If so, scoring will reflect the previous version. With a large number of submissions and resubmissions, it is not possible to track correctly without using the version numbers.

Presentations will be scheduled after submission of the document. A calendar of available time slots will be sent to all teams. Each team is to send to the competition email a list of three time slots. The team will be notified of which time slot they are assigned.

Updated presentations will not be accepted after the deadline. It is understood and expected that changes will occur between document submission and the presentation time. The scoring is based on the quality of the presentation and understanding of the competition requirements. There will be no point loss due to changes in the design between document submission time and the presentation time.

Table 1: Deliverable item due dates

Deliverable

Material Due	Required Filename Format	Due Date
PDR	cansat2021_XXXX_pdr_vYY.pdf	02/01/2021 23:59:59 UTC
CDR	cansat2021_XXXX_cdr_vYY.pdf	04/2/2021 23:59:59 UTC
Environmental Test Document	cansat2021_xxxx_env.pdf	5/28/2021 23:59:59 UTC
Flight Telemetry Data	Flight_XXXX_C.csv for the Container Telemetry, Flight_XXXX_SP1.csv for Science Payload 1, and Flight_XXXX_SP2.csv for Science Payload 2.	06/12/21
PFR	cansat2020_XXXX_pfr_vYY.pdf	06/13/2021 08:45:00 Local

XXXX is the team number. YY is the revision number. **Use this file format or your team will be removed from the competition. Files are to be in PDF format. No other formats will be accepted. Any submission after the deadline will be ignored.**

At the end of the competition, the PDR, CDR, and PFR packages may be placed on the website for reference in subsequent years.

5.5 Slide Format Guidelines

The following guidelines shall be used when developing the presentation material:
- Use the template made available. Failure to do so will result in loss of points.
- All slides shall have simple white backgrounds. This helps reduce the file sizes and makes the slides easier to read.
- All slides shall have page numbers in the footer. This is to allow for easier referencing of material during the reviews.
- All slides shall list the presenter's name in the footer. This provides all the reviewers with an identity as to who is presenting the material.
- No embedded files or movies shall be included in the presentations. Not all reviewers will be able to access or view movies during the reviews due to network security settings at the various organizations involved.
- Each line-item in the review outlines shall correspond to a dedicated slide. This may result in slides with single bullets on them, however, this makes it easier for the reviewers to follow the presentation.

5.6 Disqualification Guidelines

The following are grounds for removal from the competition.

1. Any team found to be copying a PDR/CDR document from a previous competition will be disqualified from the competition.

2. Any team not meeting the basic competition requirements by CDR will be disqualified. This means teams using requirements from previous competitions and not following the current mission guide. This is an indication of teams copying a design from a previous competition.

3. Any team submitting a PDR or CDR document that is not at least 70% complete will be disqualified.

4. Teams not demonstrating an understanding of the requirements of the competition will be disqualified.

5. Any team copying slides, content and designs from other teams will be disqualified.

6. Teams not submitting PDR and CDR documents in the required PDF format and file name convention as stated in the competition guide will be disqualified.

7. Teams not submitting PDR and CDR documents by the due dates will be disqualified.

8. Teams not scheduling presentation times by the specified date will be disqualified.

9. Teams not attending the PDR and CDR teleconference within 15 minutes of the set

time will be disqualified. Find a phone that works. It can be a computer, landline or mobile phone.

10. Teams exceeding 10 members at any time during the competition.

11. Excessive arguing with judges or any staff.

6. Launch Weekend

6.1 Schedule

All times are referenced to eastern daylight time.

The competition starts Thursday evening and ends Sunday evening.

The preflight briefing will be held Thursday at 7:30pm.

Flight readiness review and safety inspection will occur on Friday starting at 12 pm.

Saturday will be the launch day unless weather causes a postponement.

Sunday will be Post Flight Review presentations.

A detailed schedule will be provided at a later date. Be available Thursday evening until Sunday 8:00 pm.

6.2 Flight Readiness Review

Friday, teams are required to have their CanSats inspected for flight worthiness. Each team will be assigned a one half hour time slot to present their CanSat. This means the CanSat must be completed, built and ready to launch at the flight readiness review. A ball of wires and boards does not constitute flight ready. To emphasize, when presented at the Flight Readiness Review (FRR), it must be in a state where it can be turned on and placed into a rocket for immediate launch and be fully operational. **Flight Readiness Review will be scored once.**

6.2.1 FRR Sequence of Events

Teams must be prepared to demonstrate the ground station.

The first test at the FRR will be the drop test. The CanSat must be in flight configuration and will be subjected to the drop test. If the test fails, the team must make repairs before being allowed to fly. The CanSat must pass the drop test in order to be launched.

The second test will verify communications with the CanSat and demonstrate the ground station software. The ground station software operations will be scored at this time. The ground station must show data being plotted in real time.

The CanSat will then be inspected for safety. The structure will be reviewed and determined if it is flight worthy. The mounting of the electronics and sensors will be reviewed. Mechanisms will be reviewed. Hazards will be identified such as heating elements exposed to the outside, etc.

If any CanSat is determined to not be flight ready, the team has until their flight the next day to make repairs and modifications. This is done to make sure your CanSat is completed before coming to the competition and for the safety of all people on the field.

Safety is the highest priority. Any CanSat deemed not flight worthy will not be flown. The team will lose all flight day points.

Crew assignments must be submitted at the flight readiness review in the Mission Operations Manual. The mission control officer will be given an identification so the flight coordinator and launch control officer knows who is the mission control officer. The missions operations manual will be reviewed at the FRR.

Teams must show photos and videos of all environmental tests required. These tests are described in Section 3.5

6.3 Team Member Launch Operations Crew Assignments

Crew assignments must be submitted at the flight readiness review. The mission control officer will be given an identification so the flight coordinator and launch control officer knows who is the mission control officer.

The missions operations manual will be reviewed at the flight readiness review.
Team Member Launch Operations Crew Assignments

In order to have a successful launch, teams need to coordinate among themselves and with the flight coordinator. Team members need to be assigned to specific tasks and develop a checklist for a successful flight. The following task assignments must be delegated:

Mission Control Officer - This is a single person who is responsible for informing the FLight Coordinator when the team and their CanSat is ready to be launched.

Ground Station Crew - This is one or more persons who is responsible for monitoring the ground station for telemetry reception and issuing commands to the CanSat.

Recovery Crew - This is one or two persons only responsible for tracking the CanSat and going out into the field for recovery and interacting with the field judges. This crew is responsible for making sure all field scores are filled in or loss of points will occur.

CanSat Crew - This is one or more persons responsible for preparing the CanSat ,integrating it into the rocket, and verifying its status.

Team members can take on multiple roles except for the Mission Control Officer. The Mission Control Officer should be coordinating all efforts and interacting with the flight coordinator as needed. It is highly recommended that a checklist be developed that steps the crews through the preparation, integration, and flight operations.

Crew assignments must be submitted at the flight readiness review.

6.4 Mission Operations Manual

Each team is required to assemble a mission operations manual. The mission operations manual includes five checklists/operations procedures to be created by the team. The checklists are for configuring the ground station, preparing the CanSat, and integrating the CanSat into the rocket. The launch preparation procedures, launch procedure, and removal procedure are provided. Additional steps can be added by the team. The document is available for download and modification. Each section of the mission operations manual must start on its own page. Pages should be numbered and a table of contents is to be included.

The team must have the mission operations manual assembled into a three ring binder. The mission control officer must use the manual during launch. The mission control operator shall go to the microphone at the launch site and announce their team and go through their launch procedure which will include the count down to the launch.

6.5 Launch Schedule

The launch will start at 1pm. All CanSats are to be submitted at noon. The time period of 8am to 12pm is available for launch preparations and check in. This is the time to set up antennas, ground stations, and final CanSat tests and preparations.

CanSats must be submitted at the check-in by noon. Only one or two team members must be in line with the completed cansat by noon. Teams who submit CanSats after the noon deadline will lose 100 points from launch day points. CanSats must be in flight ready condition in order to be in line. Teams cannot be in line while working on the CanSat. The CanSat must be in the stowed configuration and off when submitted. Teams will be kicked out of the check-in line if they are seen working on their CanSat or their CanSat is not fully assembled in the stowed configuration.

The launch will start at 1pm and will be done in groups of five. Each team will be assigned a round which will be scheduled in one half hour increments. 15 minutes before the launch round, the teams assigned to the round shall retrieve their CanSat, turn it on and insert it into the rocket payload. CanSats shall not be disassembled at this stage. The CanSat must be flight ready and the only thing that can be done to the CanSat is to turn on the CanSat with the power switch. Any team that does not launch in their scheduled launch round will lose an additional 50 points. Any team that requires to unload their CanSat from the rocket after the rocket is mounted on the launch pad will lose an additional 50 points. Any team that requires to disassemble their CanSat will lose an additional 100 points.

Each team will be given a thumb drive to upload their ground station data after they perform their flight operation. The thumb drive must be submitted to the judging table before leaving the field.

6.6 Competition Operations and Sequence of Events

Details of flight day operations shall be provided at the Pre-Flight Brief. An overview of the flight day operations include the following activities:

1. Arrive at launch site
2. Prepare CanSat for turn in. Make it flight ready and perform any tests.
3. Turn in CanSat at the check-in table by noon. It will be weighed and fit checked and stored in the stowed configuration and off state until rocket preparation time.
4. Upon the team round, the team will collect their CanSat and load it into a rocket.
5. Verify the CanSat is communicating with the ground station.
6. Take the rocket with the ground station to the assigned launch pad. A staff member will install the rocket on the launch pad.
7. When it is time to launch, a judge will come by the ground station to monitor the ground station operation.
8. The team mission control officer will go to the launch control table and execute the launch procedures with the flight coordinator providing oversight.
9. Ground station crew will perform all required flight operations.
10. After all CanSats have launched for the current half hour round, team recovery personnel can head out to recover.
11. Ground station crew must clear out of the ground station area to allow the next round ground stations to set up.
12. Ground station crew must turn in the thumb drive with any ground station data to the ground station judge.
13. Recovery crew must return to the check-in for any final judging requirements.

Teams shall not touch the CanSat until the field judge verifies all necessary scoring information.

6.7 Second Flight Rules

Second flights are rare but do occasionally happen. The following conditions will qualify for a second flight.

1. If the rocket has a catastrophic failure. This includes the motor failing causing the rocket to crash or rocket parachute fails to deploy and crashes with the CanSat still inside. This event will require the team to have a working spare CanSat that can be prepared and made operational within an hour.

2. If the nose cone does not release, keeping the CanSat from deploying and the CanSat has passed the fit check. Containers wider than 125mm and still flown will not get a second flight.

All are contingent on enough spare motors being available.

A team whose CanSat is destroyed due to a rocket failure will receive all launch day points only if they passed the drop test, the fit check, and the FRR tests and inspections otherwise

no points will be received for the launch day.

6.8 Weather Delays

If weather conditions require the Saturday launch to be postponed to Sunday, the post flight reviews will be cancelled. Scores from PDR, CDR and the launch day will be used to determine the final rankings. Awards will be held Sunday evening.

If both Saturday and Sunday do not allow for launches, the final rankings will be based on PDR, CDR and flight readiness reviews.

Appendix A Field Safety Rules

1. Consumption of alcohol is not allowed.

2. Smoking is only allowed at designated areas. If anyone is caught smoking where it is not allowed, the landowner can throw you off the field.

3. Do not catch rockets or CanSats out of the air.

4. Stay behind the designated range line unless the range safety officer (RSO) or launch control officer (LCO) or flight coordinator has given permission to put your rocket on a pad.

5. Pay attention at all times. Every launch is potentially hazardous.

6. If a "heads up" launch is announced, you must be standing and facing the launch pad.

7. Do not retrieve a rocket from the range unless the LCO has given you permission.

8. Everyone must be alert when a "heads up!" is called and be ready to move.

9. Do not litter. Do not throw trash on the ground anywhere on the field. We have been invited to use the land owner's field and should treat it with respect. Any team caught throwing trash on the ground anywhere will be disqualified from the competition and the school will be notified of the disqualification. The landowner can order the team to leave the property and enforce the order.

Appendix B Presentation Recommendations

The following recommendations for presentation content and layout are being provided based on past experiences of the judges. These recommendations are not required to be followed but make it easier for the judges to review the material presented.

1. Use a consistent table format throughout the various subsystems when presenting requirements, component trades, and changes since previous reviews. Using a standard table format makes it easier for the judges to find the information in the table quickly since all tables are formatted the same.

2. During the CDR, the Changes Since PDR slides should use a table that contains a discussion of what the state of the design was at PDR, what it is at CDR, and what the rationale of the change was. Details of the change can be discussed in subsequent slides so an in-depth discussion is not always necessary.

3. Include the class year (freshman, sophomore, etc.) and major of each team member for reference. This doesn't play into the scoring of the team, however, it is often nice for the reviewer to know the status of the team members.

4. Be sure to follow the PDR and CDR outlines very carefully. Provide at least one chart for each scored item in the outline; this makes it easier for the judges to follow the presentation and confirm the required information is provided. In the presentation, be sure to address the questions and topics listed in the "description" column of the presentation outline -- those are the key points the judges are looking for.

5. Be clear which optional requirements, if any, are to be included in the design.

6. Be detailed in test descriptions. Identify specific tests, what is going to be done, and the pass/fail criteria.

Appendix C Payload Deployment Description

The figure illustrates a typical launch and separation sequence. Due to this nominal

deployment sequence, it is recommended that CanSat be integrated with the payload section "upside down" such that the folded CanSat parachute rests on the payload section bulk plate. The CanSat then rests on the parachute and the folded nose cone parachute rests on the CanSat. Once the ejection charge burn is completed, the payload section and nose cone separate from the rocket and tip over. The nose cone slides out of the top of the payload section and the CanSat then falls out of the payload section due to gravity.

If a mission does not require a parachute at deployment from the rocket, the nadir pointing end of the cansat shall be facing toward the nose cone.

Ejection charge separates payload/
nose section from rocket. When
front section separates from rocket
the shock chord between them pulls
the rocket parachute from the
rocket.
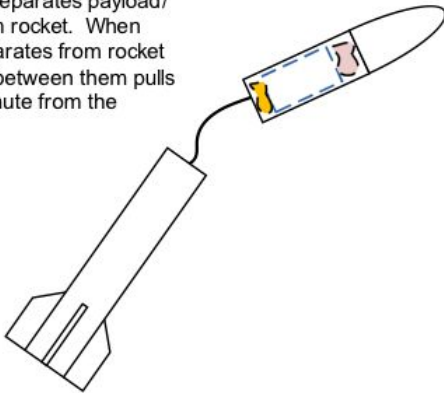
When the front section tips over, the
nose cone falls off and the cansat
falls out of the payload section. The
cansat parachute now inflates over
the cansat.
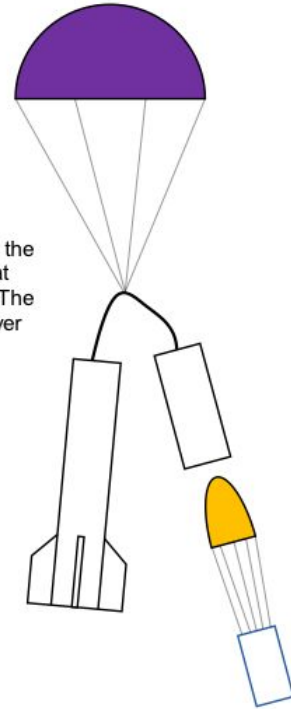
Cansat rests on its parachute.
The nose cone parachute rests on the
bottom of the cansat.
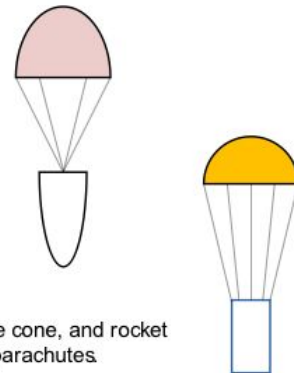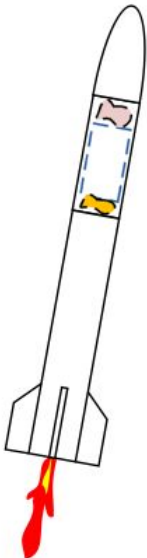
The cansat, nose cone, and rocket
descend under parachutes.

Appendix D Acronyms

A	Analysis
CDR	Critical Design Review
CONOP	Concept of Operations
D	Demonstration
DCS	Descent Control System
FRR	Flight Readiness Review
GCS	Ground Control Station
HW	Hardware
HWR	Hardware Review
I	Inspection
LCO	Launch Control Officer
PDR	Preliminary Design Review
PFB	Pre Flight Briefing
PFR	Post Flight Review
RPM	Revolutions Per Minute
RSO	Range Safety Officer
SOE	Sequence of Events
T	Test
TBD	To Be Determined
TBR	To Be Resolved
VM	Verification method

Appendix E Definitions

Analysis	Verification method that utilizes evaluation of data generated by accepted analytical techniques or simulations under defined conditions to show the item will meet the specified requirements.
CDR	A multi-disciplined technical review to ensure that the system under review can proceed into system fabrication, demonstration, and test; and can meet the stated performance requirements within cost (program budget), schedule (program schedule), risk, and other system constraints.
CONOP	Describes what the system will do and the way the system works from the operator's perspective. The CONOP is a high level description that should include a top-level block diagram.
Demonstration	Verification method that utilizes a qualitative exhibition of functional performance, usually accomplished with no or minimal instrumentation.
Inspection	Verification method that utilizes an examination of the item against applicable documentation to confirm compliance with requirements.
Need Date	Latest date a component or element (software, etc.) must be received or completed in order to not impact the end completion date.
PDR	A multi-disciplined technical review to ensure that the system under review can proceed into detailed design, and can meet the stated performance requirements within cost (program budget), schedule (program schedule), risk, and other system constraints.
Shall	Verb used to indicate a requirement is binding. All shall statements require verification.
Should	Verb used to define a goal or non-mandatory provision.
Test	Verification method utilizing operation of all or part of the item under controlled conditions, either real or simulated, to determine that the quantitative design or performance requirements have been met.
To Be Determined	An item or parameter that has not been specified at the time of document release.
To Be Resolved	An item or parameter that is preliminary or uncertain at the time of document release and for which a final value is to be specified at a later time.
Validation	Confirms that the system, as built (or as it will be built), satisfies the user's needs. Confirmation you built the right thing.
Verification	Confirms that the system, its elements, its interfaces, and incremental work products satisfy their requirements. Confirmation you built the

system right.

Will   Verb used to reference a binding or hard requirement elsewhere in the document text.

Appendix F – Payload Section

This information is provided to allow teams to build a test rocket payload section.

The payload section consists of a 20 inch long cardboard airframe tube, a coupler that slides into the air frame, a bulk plate and an eyebolt.

The top of the payload section is the open end where the cansat is inserted and the nose cone is inserted. The base of the payload section is the opposite end where the coupler is secured and the bulk plate is secured with the eyebolt.

Assembly sequence:

    10. Epoxy the bulk plate to one end of the coupler tube.

    11. Secure the eyebolt to the bulk plate. Place the washers on both sides of the bulk plate when securing the eyebolt.

    12. Epoxy the coupler into the air frame with only half the coupler inserted in the airframe. Make sure no epoxy drips onto the exposed end of the coupler tube. It has to be clean and smooth for it to fit into the rocket.

Alternative to epoxying the coupler into the airframe is to use four screws or click-lock shank rivets.
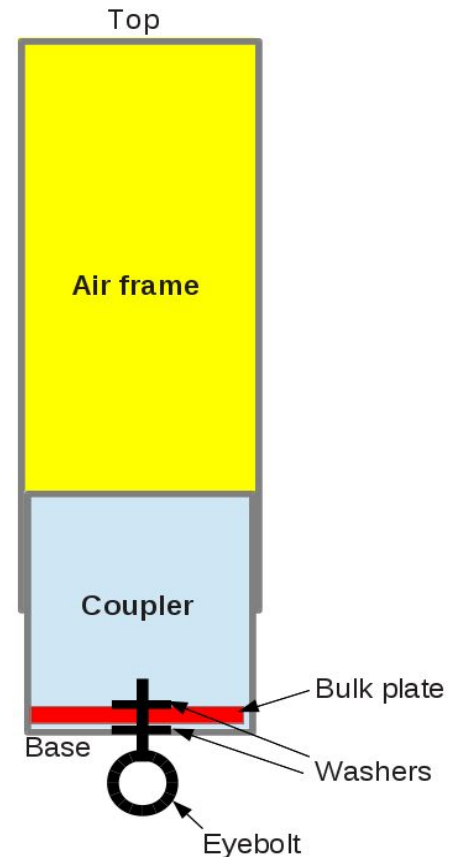
Link to the payload kit:

https://www.locprecision.com/product/payload-bays/

Select the 5.38x20 inch payload

Link to the rocket kit:

https://www.locprecision.com/product/minie-mag/

The rocket motor used will either be a Cesaroni I303 or Aerotech J425.

Appendix G - Competition Calendar

Date	Action
8/30/2020	Competition Guide is posted.
8/30/2020	Application is open to teams.
10/30/2020	Applications is closed.
11/29/2020	Application payments closed.
1/25/2021	PDR Time slot selection.
2/1/2021	PDR documents due by 23:59:59 UTC.
2/8/21-2/26/21	PDR presentations.
3/12/2021	Top 40 teams selected. Invitation letters to be requested.
3/22/2021	CDR Time slot selection.
4/2/2021	CDR documents due by 23:59:59 UTC.
4/12/21-4/30/21	CDR presentations.
5/7/2021	CDR results posed.
6/11/2021	Flight Readiness Review
6/12/2021	Launch Date
6/13/2021	Post Flight Review, Awards