Cansat
Competition Guide
2012

Mission:
Planetary Atmospheric Entry Vehicle

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Revision Summary

Rev	Date	Changes	Author
01	2011.06.13	Initial revision.	S. Reedy I. Galysh
02	2011.07.01	Adjusted values, added FRR, clean up	I.Galysh
03	2011.08.01	Made changes, finalized volume, updated payload diagram	I.Galysh
04	2011.08.26	Changed the radio configuration	I.Galysh
05	2011.09.28	Clarified descent rate on lander	I. Galysh
06	2011.11.21	Added tolerances to descent rates	I. Galysh
07	2012.01.09	Corrected lander descent rate on page 7	I. Galysh

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. The competition 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 reviews, and demonstration flights.

Mission Overview

The mission is to launch an autonomous cansat with a deployable lander containing one large raw hen's egg. The cansat consists of two parts, the carrier and the lander. The carrier holds and releases the lander. The term "cansat" shall refer to the complete system - the carrier and lander.

The cansat will be deployed from a rocket at an altitude of 450 to 670 meters (1476 to 2200 feet). Once released from the rocket, the cansat shall shall descend at 10 meters per second using any type of passive descent control system or device. At an altitude of 200 meters, cansat shall reduce the descent rate to 5 meters per second. At 91 meters altitude, the cansat carrier shall release the lander that contains one large raw hen's egg. The lander shall land without damaging the egg. The lander cannot free fall. It must contain a descent control system or device to reduce the descent rate to less than 5 meters per second. The carrier telemetry data may be stored on-board for post processing in the event of a communications failure.

Teams must build their own ground station. Telemetry from the carrier shall be displayed, in real-time, on a team-developed ground control station.

Base Mission Requirements

1. Total mass of the cansat system, excluding the egg payload, shall not exceed 750 grams or be less than 400 grams.
2. The cansat shall be compatible with the Loc/Precision Mini-Magg rocket as specified in the payload definition section.
    1. The cansat, including descent control devices shall fit inside the cylindrical payload section of the rocket defined by the cylindrical envelope of 130 mm diameter and 152 mm in length (see Payload Envelope Definition section).

2. The parachute, streamer, or other type of recovery material may occupy an additional 76 mm above or below the cansat.
3. No protrusions beyond the envelop defined in the requirement are allowed until the cansat has been deployed from the rocket payload section.
4. The rocket airframe cannot be used to restrain any deployable parts of the Cansat.
5. The rocket airframe and payload sections shall not be used as part of the cansat operations.
6. The Cansat shall deploy from the launch vehicle payload section.

3. The cansat shall comply with the following descent and recovery requirements
    1. The descent control system shall not use any flammable or pyrotechnic devices.
    2. The cansat descent rate shall be 10 meters per second +/- 1 meter per second after being deployed while 200 meters above the ground using a passive descent control device such as a parachute or streamer.
    3. When the cansat goes below 200 meters, the cansat descent rate must be reduced to 5 meters per second +/- 1 meter per second.
    4. At 91 meters, the lander must be deployed.
    5. The average descent rate of the Cansat lander after deployment shall be less than 5 meters/second and drift less than 500 meters.
    6. All cansat carriers and landers shall include an audible locating device rated at 80 dB or higher (such as a buzzer) and operate for at least three hours.
    7. Locator devices shall be independently powered with dedicated external power switches.
    8. Prior to lander deployment, the cansat (carrier + lander) shall descend as a single unit.
    9. All descent control systems or devices must be capable of handling 30g shock force.
    10. Altitude must be determined using a sensor other than GPS and must be sampled at a sufficient rate to accurately determine the current altitude at a 2 meter accuracy or better.
4. The cansat shall comply with the following communications requirements
    1. The cansat communications radio shall be the XBEE radio model number XBP24BZ7SIT-004 or XBP24BZ7UIT-004 depending on the antenna connection preferred.
    2. The Zigbee radios shall have their NETID set to the team number.
    3. The cansat radio shall not use the broadcast mode.
    4. The ground control station antenna shall be elevated a minimum of 3.5 meters (11.5 feet) from ground level to ensure adequate coverage and range.
    5. The cansat shall not transmit telemetry until commanded by the team ground station. Commanding can be executed while the cansat is in the rocket on the launch pad.

5. The Cansat and associated operations shall comply with all field safety regulations as outlined in Field Safety Rules section.
6. The cansat shall be launched within the assigned launch window. Failure to do so will result in 50% reduction of the total flight operation score unless failure is determined to be external causes.
7. The cansat shall comply with the following power requirements:
    1. The carrier and lander shall have an external power control such as a power switch and some indication of being turned on or off. The idea is to keep teams from tearing apart their cansat to turn it on or off which has led to many failures in the past.
    2. The cansat shall have battery capacity to support up to a one hour wait on the launch pad plus time for flight operations.

    3. The cansat shall not utilize lithium polymer (LiPo) batteries. Lithium Ion batteries, LiFePO4 cylindrical cells, NiMH, NiCd, and alkaline batteries are allowed. Other types must be approved before use.
8. The cost of the cansat flight hardware shall be under $1000 (US). Ground support and analysis tools are excluded.
9. Each team shall develop and use their own ground station. All telemetry shall be displayed in real-time during launch and descent. All telemetry shall be displayed in engineering units (meters, meters per second, Celsius, etc.). Teams shall plot data in real-time during flight.

Carrier Requirements (Part of Base Requirements)

1. The carrier shall comply with the following descent and recovery requirements:
    1. The descent control system shall not use any flammable or pyrotechnic devices.
    2. The carrier shall activate an audible locating device (such as a buzzer) upon landing. The audible devices shall not be activated during pre-launch and launch activities. The audible device shall operate for at least three hours following activation.
    3. The descent control system and its attachment points must support 30 Gees of shock force.
    4. The attachment points of the descent control systems must designed to be able to be tested at the flight readiness review. This means they can be unstowed or released and tested.
    5. If parachutes or streamers or parafoils are used, the color must be florescent pink or florescent orange to aid in acquisition and tracking during descent.
2. Structure Requirements
    1. All electronics shall be enclosed and shielded from the environment. No electronics can be exposed except for sensors. There must be a structural enclosure.

2. The structure must support 10 Gees acceleration.
3. The structure must survive 30 Gees shock force.
4. Electronic circuit boards must be hard mounted using proper mounts such as standoffs and screws. High performance adhesives are acceptable.
5. Team number, email address and a phone number must be placed on the structure to aid in recovery.

3. Mechanisms Requirements
    1. Mechanisms must be capable of maintaining their configuration or states under all forces such as acceleration and shock forces.
    2. Mechanisms must not use pyrotechnics or chemicals.
    3. Mechanisms that use heat (e.g. nichrome wire) must not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.
4. During descent, the carrier shall transmit the following telemetry data once every two (2) seconds:
    1. GPS data including:
        1. UTC time
        2. latitude in degrees
        3. longitude in degrees
        4. mean sea level altitude
        5. number of satellites tracked
    2. Altitude in meters via a non GPS sensor. The altitude can be calculated on the cansat or on the ground station.
    3. Air temperature in Celsius.
    4. Battery voltage in Volts.

Lander Requirements (Part of Base Requirements)

1. The lander shall safely land a single large Grade A hen's egg from an altitude of 91 meters.
2. The lander shall comply with the following descent and recovery requirements:
    1. The descent control system shall not use any flammable or pyrotechnic devices.
    2. Following separation from the carrier, the lander descent rate shall be less than 5 meters per second. This must be measured and recorded. Telemetry is not required for the lander.
    3. The lander shall include an audible locating device (such as a buzzer). The audible device shall operate independently with its own power source for at least three hours.
3. Structure Requirements
    1. All electronics shall be enclosed and shielded from the environment. No electronics shall be exposed.
    2. The structure must support 10 Gees acceleration.

3. The structure must survive 30 Gees shock force.
4. Electronic circuit boards must be hard mounted using proper mounts such as standoffs and screws. High performance adhesives are acceptable.
5. Team number, email address and phone number must be placed on the structure to aid in recovery.

Selectable Objective Requirements

Each team shall select one, and only one, of the following options as part of their mission design:

1. The lander cansat shall measure the force of impact with the ground. Data shall be collected at a rate of at least 100 Hz and stored on-board for post processing.
2. Following separation of the lander, the carrier shall obtain images in the nadir direction, with at least one image containing the lander in it. The images shall be stored on-board the carrier for post-processing following recovery. The team may telemeter the images to the ground, however, no points shall be awarded for this.
3. The carrier shall capture video of the lander release. The video camera must be triggered to start no more than 2 seconds before lander release. The video can be stored onboard for retrieval after recovery. Video capture cannot be started at the time the cansat is inserted into the rocket.
4. The lander shall capture video of the descent after release pointing to the horizon with a spin rate of less than 10 rotations per minute. The video capture must start no more than 2 seconds before the lander is released from the carrier.

Communications Protocol

The XBEE radios to be used are model XBP24BZ7SIT-004 or XBP24BZ7UIT-004. Each model has a different type of antenna connection.

There is a specific configuration mode required for proper operations. The ground station XBEE radio must be configured as COORDINATOR AT. The CanSat XBEE radio must be configured as ENDPOINT AT. Both XBEE radios must use the same PANID number and that number shall be the team number. The ground station XBEE radio destination address shall be the CanSat XBEE radio address as indicated in the SH and SL parameters. The CanSat XBEE radio address shall be the ground station XBEE radio address indicated in the SH and SL parameters.

Make sure when configuring the XBEE radios, the AT mode is chosen. This allows transparent communications between the radios so packets do not need to be built up.

The data can be formatted any way desired as long as all required data is transmitted and received and can be identified at the ground station.

Team Composition

Team Members Classification

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.

Team Size

Each team shall consist of between 3 and 10 students (undergrad teams) from an accredited college or university. Teams may consist entirely of undergraduate students (undergrad 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.

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.

Team Mentors

Each team will be assigned a competition mentor who acts as a liaison between the team and the competition committee. The mentor will be responsible for scheduling all

competition reviews and coordinating all communications with the team. Mentors are also responsible for tracking the team's progress throughout the competition.

Team mentors are available to answer questions and provide general guidance. The mentor shall not provide design recommendations.

Deliverable Items

The system shall 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.

Preliminary Design Review

The PDR is "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". 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) and mentors. The PDR presentations shall be ***less than 60 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 outline in "Cansat 2011 PDR Outline" document available on the Cansat Competition website. Extra material in the form of backup slides is permitted.

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

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) and mentors. The CDR presentations shall be ***less than 60 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 outline specified in the "Cansat 2011 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.

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 10-15 minutes, including questions, based on the number of teams participating.

The presentation shall follow the outline specified in the "Cansat 2011 PFR Outline" document available on the Cansat Competition website. Extra material in the form of backup slides is permitted.

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.

Deliverable Submissions and Scheduling

All deliverable items shall be submitted to the team mentor by the dates listed in Table 1. All deliverable items shall be submitted in PDF format using the naming listed in Table 1 where Team_# 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 Team number 101 of version 2 of the PDR package would be named “Cansat2012_Team_101_PDR_v02”.

All reviews shall be completed within 2 weeks of the “Material Due” dates in Table 1. Teams shall submit to their mentors, a list of 3 date and time choices for each review by the dates listed in the “Schedule By” column of Table 1. These dates and times should provide different opportunities for judges to be scheduled and to avoid conflicts with other reviews – e.g. the date/times should not be 3 different 1-hour slots on the same day that would not provide opportunities to get different judges. Teams will be notified within 1 week of the “Schedule By” date as to the final date and time for the review, along with information about the telecon. Reviews not completed within the 2 week time frame risk loss of points for the reviews. Reviews not completed due to competition, mentor, or judge conflicts shall not be penalized.

Teams are encouraged to submit and complete reviews prior to the dates listed if they are prepared to do so.

Table 1: Deliverable item due dates

Deliverable	File Name	Schedule By	Material Due
PDR	Cansat2012_Team_#_PDR_v#	Feb 1, 2012	Feb 1, 2012
CDR	Cansat2012_Team_#_CDR_v#	Mar. 29, 2012	Mar. 29, 2012
Demo Flight	N/A	N/A	June 9, 2012
PFR	Cansat2012_Team_#_PFR_v#	June 10, 2012	June 10, 2012

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

Post Flight Review packages shall be submitted to the designated competition representative via thumb-drive (not provided by the competition). All presentations shall be submitted at the start of the assigned presentation sessions.

Slide Format Guidelines

The following guidelines shall be used when developing the presentation material:

1. Use the template made available. Failure to do so will result in loss of points.
2. All slides shall have simple white backgrounds. This helps reduce the file sizes and makes the slides easier to read.
3. All slides shall have pages numbers in the footer. This is to allow for easier referencing of material during the reviews.
4. All slides shall list the presenters name in the footer. This provides all the reviewers with an identity as to who is presenting the material.
5. 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.
6. 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.

Demonstration Flight

Schedule

The competition starts Friday at 1 PM. From 1 PM until 6 PM, teams must attend their assigned flight readiness review time slot. Each team will be given 30 minutes to complete their flight readiness review. Teams will have deficiencies identified and must have them corrected to be allowed to fly.

The Pre-Flight Briefing will be held at 7:30 PM. It will last about 30 minutes. After the PFB, time will be available for teams to demonstrate corrections made to deficiencies identified during their flight readiness review. Teams that do not correct the deficiencies by 10 PM will have an opportunity Saturday morning to demonstrate the corrections.

Saturday morning, the launch site opens at 8 AM. Teams have until 9 AM to demonstrate that their deficiencies have been corrected. The first launch occurs at 10 AM. Range closes at 4 PM.

Sunday, the post flight briefings start at 9:30 AM at the Texas State Technical College. All teams are to arrive at the facility by 9 AM. Depending on the number of teams, the preflight briefings may end by 5 PM with the awards given at 6 PM.

Pre-Flight Briefing

The evening prior to launch day, a pre-flight briefing (PFB) shall be held. All teams are required to attend the PFB. The briefing will include:

- Review field safety rules
- Review launch day sequence of events
- Launch windows assignment
- Receive team packets

Flight Readiness Review

Each team will be assigned a time slot for their flight readiness review. Teams must be at the flight readiness review in order to fly the next day. Teams cannot wait until Saturday to perform the flight readiness review.

Teams will be given a flight card at the flight readiness review. The team must hold on to the card and present it where required during the flight readiness review and during the launch Saturday. The flight card is to be submitted at the end of the day at the field.

All teams shall demonstrate proper operations of their cansat and ground control station. Each team must demonstrate the capability to transmit commands, obtain and transmit telemetry, and display descent telemetry data to meet base mission requirements. Part of this demonstration ensures that the communications subsystem is properly configured to prevent interference between teams during launch operations.

Cansats will 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 highest priority. Any cansat deemed not flight worthy will not be flown. The team will lose all flight day points.

A flight readiness review test procedure will be posted so each team can perform it prior

to the flight readiness review.

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 check list for a successful flight. The following task assignments must be delegated:

Mission Control Officer - This is a single person who is responsible for letting the flight coordinator know if 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 more persons 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 check list be developed that steps the crews through the preparation, integration, and flight operations.

Crew assignments must be submitted at the flight readiness review.

Mission Operations Manual

Each team is required to assemble a mission operations manual. The mission operations manual includes three check lists/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 and 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 to be included.

The team must make at least two copies of the procedures and assembled into three ring binders. One binder will be given to the flight coordinator.

Launch Schedule

Five launches will occur on the hour for how ever many hours that are required to launch all teams. Teams will be assigned a specific launch hour. Teams have until 10 minutes before the launch hour to integrate their cansat into a rocket and have the rocket placed on the launch rail. Any team not ready to be placed on the launch pad ten minutes before the hour will not be placed on the pad and have to be rescheduled if there is time. At the launch hour, all rockets on the launch pads will be launched in sequence. This will be repeated each hour. Teams not meeting their launch schedule may be rescheduled, not guaranteed, but will have their flight operation scores reduced by 50%. Realize that the flight operations make up 35% of the total scores.

The schedule is as follows:

09:00 - 09:50 1st integration
09:50 - 10:00 All scheduled flights installed on launch pads.
10:00 - 10:25 All five flights launched.
10:00 - 10:50 Second Integration
10:50 - 11:00 All scheduled flights installed on launch pads.
11:00 - 11:25 All five flights launched.
11:00 - 11:50 Third integration
11:50 - 12:00 All scheduled flights installed on launch pads.
12:00 - 12:25 All five flights launched.
12:00 - 12:50 Fourth integration
12:50 - 13:00 All scheduled flights installed on launch pads.
13:00 - 13:25 All five flights launched.

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. Check-in with flight line judge. The flight line judge will perform the following tasks:
    - Weigh cansat assembly
    - Perform fit-check of the cansat using a sample payload section

    - Assign egg to team
3. Prep and test cansat for flight
4. Upon opening of launch window, team will request a rocket from flight coordinator
5. Flight coordinator will take the team and rocket to launch pad to prepare for flight. At this time, pictures for the competition and team may be taken.
6. The MIssion Control Officer will stand at the launch control table and execute the launch procedures.
7. Following separation from rocket, team should monitor telemetry during descent.
8. Once all launches have occurred for the hour, the down range will be opened for access to the recovery crew.
9. The recovery crew will locate a field judge out in the field and provide the field judge with the score card.
10. The field judge will score all flight and landing requirements then give permission for the team to recover their cansat parts.

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

Evaluation and Scoring

Teams shall be scored on all design reviews and deliverable items as well as the demonstration flight operations. Each deliverable shall contribute to the overall score according to the values listed in Table 2.

Table 2: Summary of competition scoring

Deliverable	% of Total Score
Administrative	10
Preliminary Design Review (PDR)	20
Critical Design Review (CDR)	20
Flight Operations	35
Post Flight Review	15

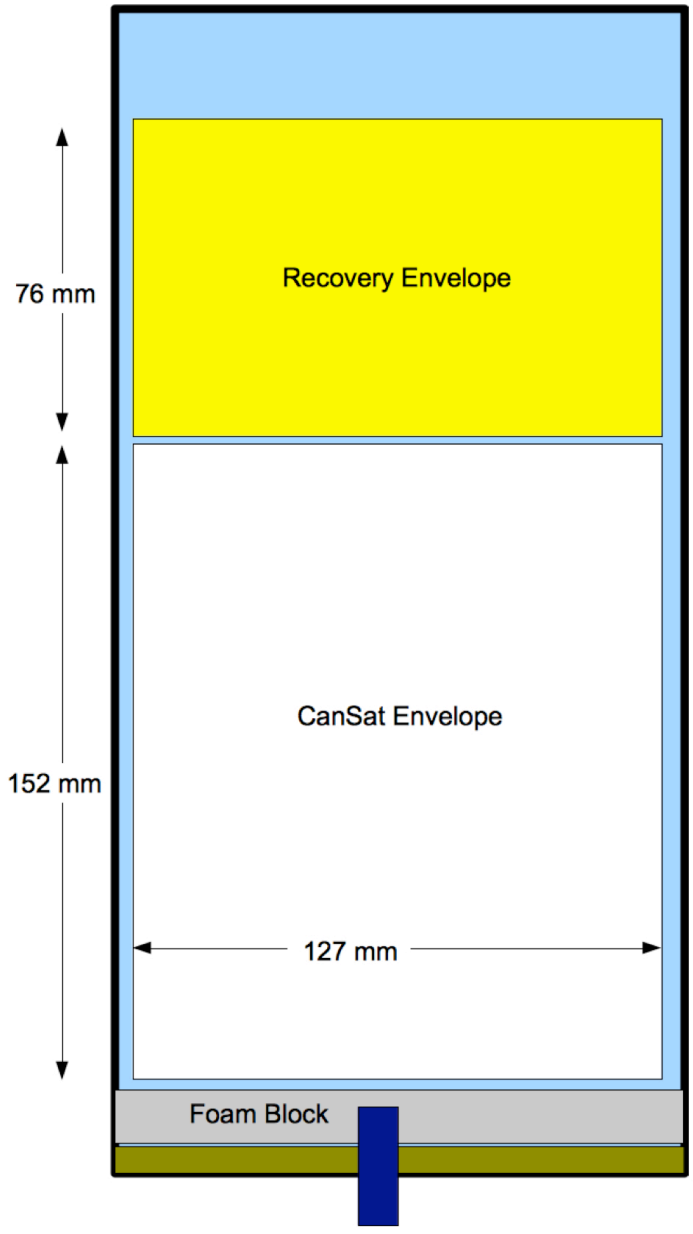
Bonus points are scored in addition to the basic mission scoring. This results in possible scores greater than 100% of the total possible points for the basic flight operations.

Each team shall receive a link to their scores for the competition. Scores will be updated within one (1) week of completing the reviews. Questions related to scoring should be addressed to the team mentor.

Appendix A Field Safety Rules

1. Consumption of alcohol while rockets are being launched is not allowed.
2. Smoking is only allowed at designated areas. If any one is caught smoking where it is not allowed, the land owner can throw you off the field.
3. Do no 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 had 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 land owner can order the team to leave the property and enforce the order.**

Appendix B Payload Envelope Definition



Appendix C Presentation Recommendations

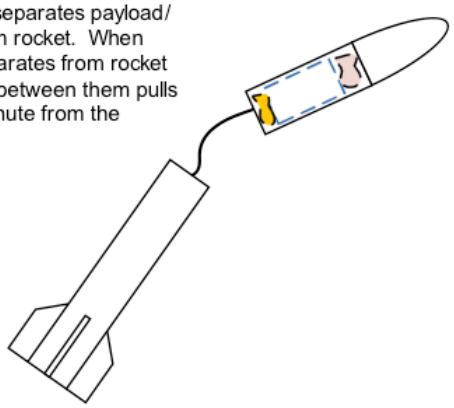
The following recommendations for presentation content and layout are being provided based on past experiences of the judges. These recommendations are not required to be followed but make it easier for the judges to review the material presented.

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.
7. For requirements matrices, follow the format in Requirements Matrix section of the competition guide. This is a fairly standard industry format. You should find more about the verification methods on the net. What the judges are looking for in this table is not just a repeat of the competition "base requirements" but also any derived requirements that you can determine for each subsystem.

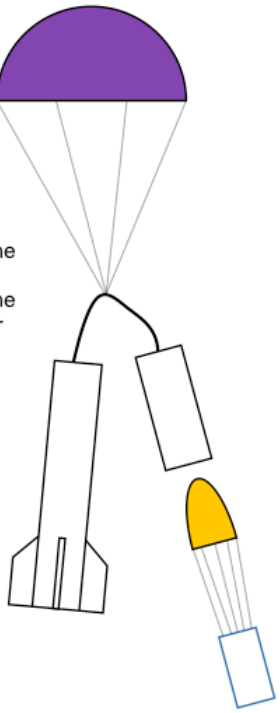
Appendix D Payload Deployment Description

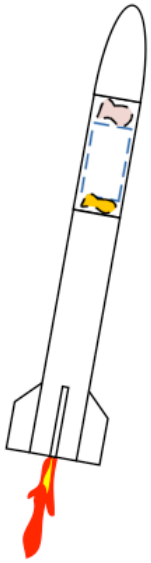
The figure illustrates a typical launch and separation sequence. Due to this nominal deployment sequence, it is recommended that cansat be integrated with the payload section “upside down” such that the folded cansat parachute rests on the payload section bulk plate. The cansat then rests on the parachute 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.

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.

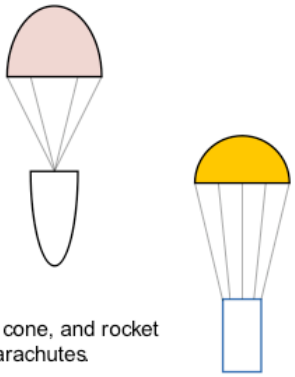


When the front section tips over, the nose cone falls off and the cansat falls out of the payload section. The cansat parachute now inflates over the cansat.





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 E Acronyms

A	Analysis
CDR	Critical Design Review
CONOP	Concept of Operations
D	Demonstration
DCS	Descent Control System
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
RSO	Range Safety Officer
SOE	Sequence of Events
T	Test
TBD	To Be Determined
TBR	To Be Resolved
VM	Verification method

Appendix F 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 G Requirements Matrix

Each deliverable item should include a listing of requirement – at the systems and subsystems levels. Each section should present requirements in the format specified in the Requirements Table Format. Each field in the table should be appropriately filled in per the descriptions in Definition of requirements table below. During presentations, it is not necessary to review each requirement, but rather to highlight important requirements that are driving the design and analysis of the cansat system. The tables should be formatted so each requirement can be read, and may flow onto several slides.

ID	Requirement	Rationale	Priority	Parent(s)	Child(ren)	VM			
						A	I	T	D

Requirements table format

Definition of requirements related terms

Item	Description
ID	Unique requirement identification. Example could be DCS-01, SEN-10, etc.
Requirement	Definition of the requirement. The requirement statement should be concise and indicate a design feature, constraint, objective (performance or physical) and associated parameters necessary to specify the design. Requirement statements should use the "shall" or "will" terminology. Requirement statements related to performance or physical attributes shall specify target values and ranges, when applicable.
Rationale	Brief statement of why the requirement is necessary.
Priority	Level of importance of the requirement. The priority shall be specified in terms of: • High: Requirement necessary for mission success. • Medium: Requirement that contributes to, but does not drive, mission success. • Low: Optional requirement that if not implemented will result in little loss of functionality or performance.
Parent	Higher level requirements that the current requirement flows from.
Children	Lower level requirement this requirement drives.
VM	Verification method. This indicates how the requirement shall be verified and includes the Analysis (A), Inspection (I), Test (T), and Demonstration (D) methods.

Appendix H Banner Source

Each team is encouraged to create a team banner. The banner will be put on display along the flight line for all to see and to be photographed. Banners should be 6 foot x 2 foot. This is the banner printer we use. They are very low cost and pretty good quality. All you need to do is generate a 600 dpi jpeg file for them to print. We will provide stakes to set up.

http://www.sportswearforall.com/bannersignsexpress/full_color_banner.htm