CanSat Competition Guide
2013

Mission: Sensor Delivery System

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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. 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.

2. Mission Overview

This mission simulates delivering a sensor payload to a planet's surface (assumes the planet has an atmosphere).

The overall CanSat system is composed of two primary components, a science payload (large hens egg) and a re-entry containerthat protects the payload during ascent, "near-apogee" deployment and initial re-entry/descent.

Once the deployed container/payload system reaches a low enough altitude the payload is released from the container to gently descend and safely land with the sensor (egg) intact. All operations are to be autonomous. "Near apogee" deployment will occur at an altitude of approximately 670 meters. Upon deployment from the rocket the container and payload shall descend at approximately 20 meters per second using any passive descent control system. At an altitude of approximately 400 meters the payload shall be released from its container and descend under it's own control to a safe landing, keeping the egg intact. The safe landing shall be accomplished without using a parachute, para-foil, streamer, or any similar device to reduce its speed. Descent rate shall be kept at 20 m/s or less. After release, the descent rate of the container shall not be maintained.

3. Requirements

3.1 Base Requirements

1. Total mass of cansat, container, and all descent control devices shall be 700 grams. Mass shall not vary more than +/-10 grams.
2. The cansat must be installed in a container to protect it from deployment out of the rocket.
    1. The container shall fit inside the cylindrical payload section of the rocket defined by the cylindrical payload envelope of 130 mm x 250 mm length including the descent control sysem.

2. The container must use a descent control system. It cannot free fall.
3. The container shall not have any sharp edges that could cause it to get stuck in the rocket payload section.
4. The container must be a florescent color, pink or orange.
5. No protrusions beyond the envelope defined are allowed while stowed in the rocket.
6. The rocket airframe cannot be used to restrain any deployable parts of the cansat.
7. The rocket airframe and payload section shall not be used as part of the cansat operations.
8. The cansat shall deploy from the rocket 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 20 meters per second +/- 1 meter per second after being deployed while 400 meters above the ground using a passive descent control device such as a parachute or streamer.
    3. When the cansat goes below 400 meters, the cansat shall deploy aero-braking structure to reduce the descent rate to 20 m/s or less.
    4. All cansats must include a audible locating device rated above 80 dB and operate for at least three hours. It may be activated at launch or at landing.
    5. All descent control device attachments must survive 30 Gees of shock.
    6. All descent control devices must survive 30 Gees of shock.
4. The Cansat shall comply with the following communications requirements
    1. The cansat communications radio shall be the XBEE radio series 1 or 2.
    2. The XBEE radios shall have their NETID set to the team number.
    3. The XBEE 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. It must be secured so it cannot fall.
    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.
    6. The XBEE radio can operate in any mode as long as it does not interfere with other XBEE radios.
5. The cansat shall comply with the following power requirements:
    1. The cansat 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 dis-assembling 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.
6. The cansat shall comply with the following flight software requirements:

    1. The flight software shall maintain and telemeter an indicator of the cansat flight software state. An example set of states is 0 (BOOT), 1 (TEST_MODE), 2 (LAUNCH_PAD), 3 (ASCENT), 4 (ROCKET_DEPLOY), 5 (DESCENT), 6 (CANSAT_RELEASE), and 7 (IMPACT).
    2. In the event of a processor reset during the mission, the flight software shall be able to determine the correct state.
    3. The states shall be described in the PDR and CDR presentations.
7. The cost of the cansat flight hardware shall be under $1000 (USD). Ground support and analysis tools are excluded.
8. 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.
9. 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.
10. 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.
11. During descent, the payload shall transmit the following telemetry data once every two (2) seconds:
    1. GPS data including UTC time, latitude, longitude, mean sea level altitude, and number of satellites tracked.
    2. Altitude in meters above sea level via a non GPS sensor.
    3. Air temperature..
    4. Battery voltage in volts.
    5. Flight software state.
    6. Flight software maintained mission time.

3.2 Selectable Objective Requirements

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

1. The Cansat shall measure the impact force with the ground. Data shall be collected at a rate of at least 100 samples/second and stored on board for post processing.
2. A video camera shall be activated at the time of release and capture video of the descent to landing with the camera facing toward the ground. The video can be

downloaded after retrieving the cansat.

3.3 Telemetry Requirements

1. Upon activation command, the cansat shall transmit telemetry packets of comma separated fields followed by a carriage return character in the following ordered format every two (2) seconds:

   CANSAT,<TEAM_ID>,<MISSION_TIME>,<GPS_TIME>,<GPS_LAT>,<GPS_LONG>,<GPS_ALT>,<GPS_SAT>,<ALT_SENSOR>,<TEMP>,<BAT_V>,<STATE>[,<CUSTOM>[,<CUSTOM>]]

   where

   CANSAT = the fixed string "CANSAT"

   <TEAM_ID> = the four digit assigned team id number

   <MISSION_TIME> = the software maintained mission time in integer seconds

   <GPS_TIME> = the local time from GPS in the following format: HH:MM:SS

   <GPS_LAT> = the GPS latitude from the NMEA message, including N or S, in the following format: DDMM.mmmmN

   <GPS_LONG> = the GPS longitude from the NMEA message, including E or W, in the following format: DDDMMM.mmmW

   <GPS_ALT> = the GPS altitude in meters above sea level from the NMEA message

   <GPS_SAT> = the number of GPS satellites being tracked from the NMEA message

   <ALT_SENSOR> = the altitude in meters as measured from the alternate altitude sensor with one decimal place of precision (e.g 675.5) in meters above sea level.

   <TEMP> = the measured air temperature in degrees C to one (1) degree resolution

   <BAT_V> = the payload battery voltage in volts to one tenth (0.1) volt resolution

   <STATE> = an integer value indicating the state of the flight software. States are to be defined by each team. An example set of states for the CanSat flight software may be 0 (BOOT), 1 (TEST_MODE), 2 (LAUNCH_PAD), 3 (ASCENT), 4 (ROCKET_DEPLOY), 5 (DESCENT), 6 (CANSAT_RELEASE), and 7 (IMPACT). The states shall be described in the PDR and CDR presentations.

   [,<CUSTOM>[,<CUSTOM>]] = if additional telemetry fields are desired, they are

to be appended to the required telemetry fields.

2. The telemetry for the entire mission shall be saved on the ground station computer as a comma separated value (.csv) file that will be examined by the competition judges in Excel. Teams will provide the file to the judges after the launch operations via USB drive or CD.
3. The telemetry data file shall be named as follows:

   CANSAT2013_TLM_<TEAM_ID>_<TEAM_NAME>.csv

   where the team_id is the four digit team id number and <team_name> is to be selected by each team (using underscores instead of spaces in the file name).

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.

4.1Team 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.

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.

4.3 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.

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- 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 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 outline 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) 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 2013 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 10-15 minutes, including questions, based on the number of teams participating.

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.

5.4 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.pdf". Note that adherence to the file name and format specification is scored during the competition.

All reviews shall be completed within 2 weeks after 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 due dates listed in 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 of 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

Material Due	Filename Format	Due Date
PDR	Cansat2013_Team_#_PDR_v#.pdf	Feb 1, 2013
CDR	Cansat2013_Team_#_CDR_v#.pdf	March 29, 2013
Demo Flight	NA	June 8, 2013
PFR	Cansat2013_Team_#_PFR_v#.pdf	June 9, 2013

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.

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 pages numbers in the footer. This is to allow for easier referencing of material during the reviews.
- 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.
- 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.

6. Demonstration Flight

6.1 Schedule

All times are referenced to central daylight time.

The competition starts Friday at noon and ends Sunday evening.

Flight readiness review and preflight briefing will occur on Friday. The preflight briefing starts 7:30pm.

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

Sunday will be post flight presentations.

A detailed schedule will be provided at a later date. Be available Friday at noon until Sunday 6:00pm.

6.2 Flight Readiness Review and Inspection

Starting at noon, 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.

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.

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.

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 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.

6.4 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.

6.5 Launch Schedule

Launch windows will be assigned to each team. Launch windows are one hour periods in which the teams need to launch. If the cansat is not on the launch pad by the end of the launch window hour, the team will be considered late and penalized. Launch window assignments will be completed after CDR.

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. Check-in with flight line judge. The flight line judge will perform the following tasks:
    1. Weigh cansat assembly without egg
    2. Perform fit-check of the cansat using a sample payload section
    3. Perform antenna mast height check
    4. Selection of egg payload
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 team ground station crew shall check in with a line judge who will witness the command to initiate telemetry transmission which will be displayed on the team ground station computer.

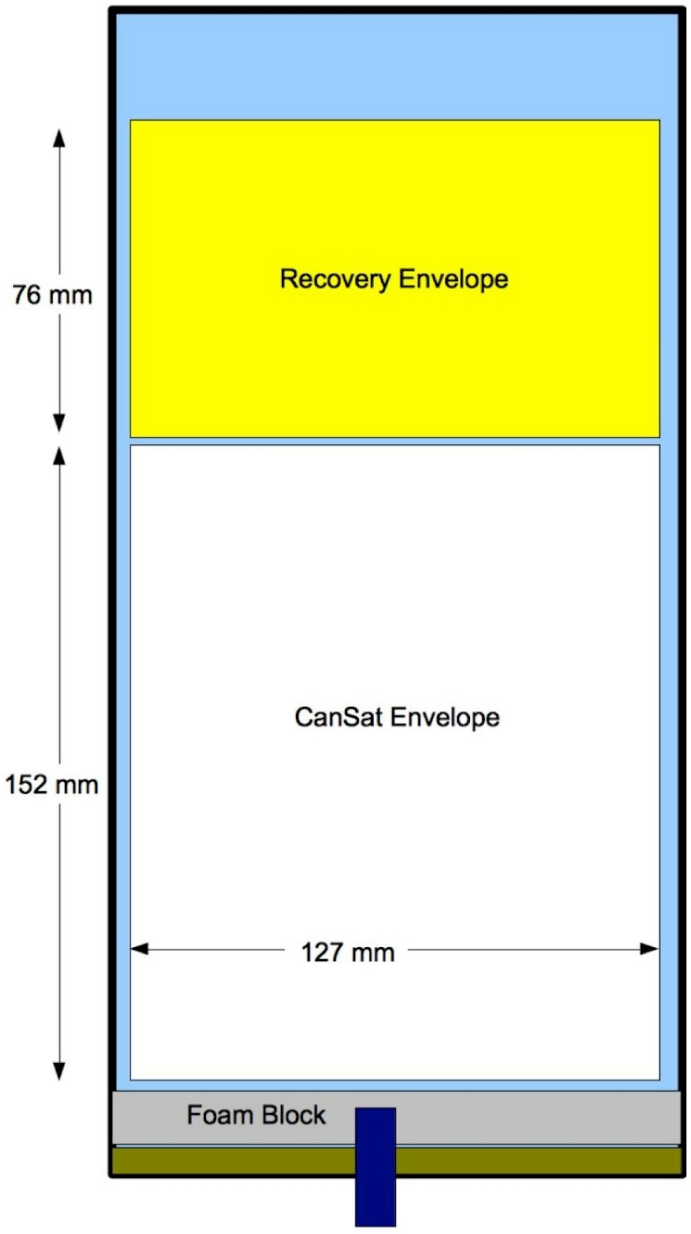
7. The team mission control officer shall confirm with the ground station crew that telemetry reception has been confirmed by line judge before continuing with launch operations.
8. The Mission Control Officer will stand at the launch control table and execute the launch procedures with the flight coordinator.
9. Following separation from rocket, team should monitor telemetry during descent.
10. Once all launches have occurred for the hour, the down range will be opened for access to the recovery crew.
11. The recovery crew will locate a field judge out in the field and provide the field judge with the score card.
12. The field judge will score all flight and landing requirements then give permission for the team to recover their cansat parts.
13. The ground system crew will deliver the telemetry data file to a line judge for inspection.

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

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



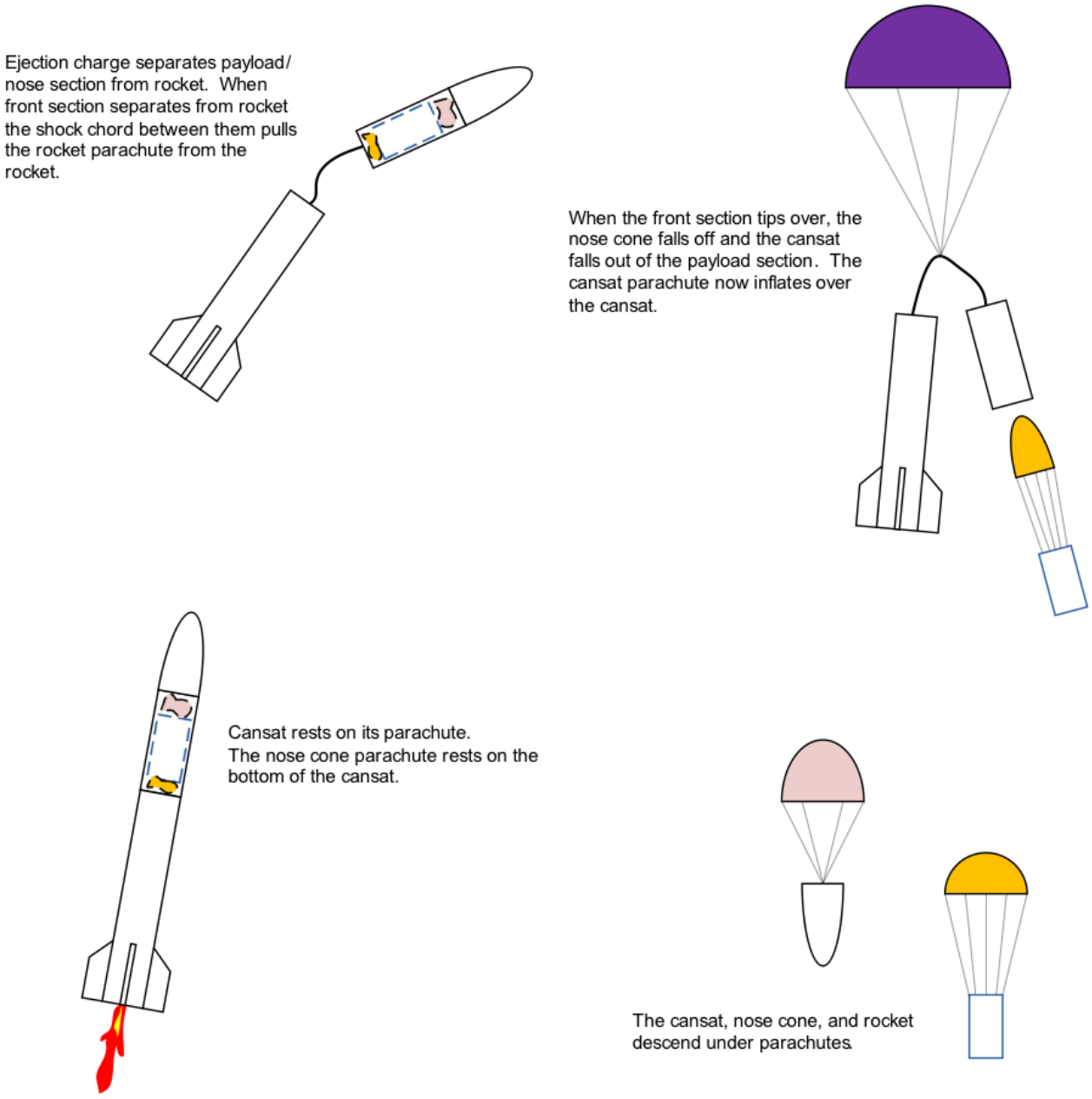
Appendix C Presentation Recommendations

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.

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.



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.