CanSat Competition Guide
2015

Mission:
Auto-Gyro Recovery Imager

Version 1.0

Table of Contents

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

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 in is the application phase. Teams must submit an application and a $100 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 31.

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 in only 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.

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 in only 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.

Phase four is the launch weekend. Friday, teams will be scheduled to present their completed CanSat for flight readiness review. The CanSat must be ready to launch at this time. It must be completely assembled and operational. Teams must pass the flight readiness review in order to be launched. Details of tests to be performed Friday will be given later.

Saturday is the launch where teams will perform final preparations and turn in CanSats by 12:00 noon 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. 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.

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.

2. Mission Overview

The 2015 mission simulates a Science Vehicle traveling through a planetary atmosphere sampling the atmospheric composition during descent.

The overall CanSat system is composed of two primary components, a Science Vehicle and a re-entry Container that protects the vehicle during ascent, "near-apogee" deployment from the rocket and initial re-entry/descent.

When initially deployed from the rocket, the re-entry Container shall descend via parachute with the Science Vehicle secured within the Container. At any desired point after the initial deployment from the rocket the Container and Science Vehicle shall separate and the Science Vehicle will begin normal operations. Note: The intent of the Container is to protect the Science Vehicle from the violent deployment from the rocket and provide a more stable release environment.

When the Science Vehicle is released from the Container, it shall use passive helicopter/auto-gyro recovery method reduce its descent rate to less than 10 meters/second. The Science Vehicle must stabilize and descend properly at a minimum altitude of 300 meters.

During descent, the Science Vehicle shall record video in the nadir (Earth pointing) direction until it lands. The video camera must be stabilized in real time during descent so that the video image of the ground is not spinning. The video can be recorded on-board for downloading after recovery. The video cannot be post processed to remove the spin of the ground image. The Science Vehicle shall collect telemetry data during descent which includes; altitude based on barometric air pressure, outside air temperature, inside temperature, flight software state, stabilization parameters, battery voltage, and bonus telemetry. The data shall be transmitted at a 1 Hz rate to a ground station.

When the Science Vehicle lands, transmission shall automatically stop and an audio beacon shall be activated automatically for recovery.

The Science Vehicle shall hold one large raw hen’s egg and protect it from breaking during the mission.

3. Requirements

3.1 Base Requirements

Requirement Number	Requirement
1	Total mass of the CanSat (Container and Science Vehicle) shall be 600 grams +/- 10 grams not including the egg.
2	The Science Vehicle shall be completely contained in the Container. No part of the Science Vehicle may extend beyond the Container.
3	The Container shall fit in the envelope of 125 mm x 310 mm including the Container passive descent control system. Tolerances are to be included to facilitate Container deployment from the rocket fairing.
4	The Container shall use a passive descent control system. It cannot free fall. A parachute is allowed and highly recommended. Include a spill hole to reduce swaying.
5	The Container shall not have any sharp edges to cause it to get stuck in the rocket payload section.
6	The Container shall be a florescent color, pink or orange.
7	The rocket air frame shall not be used to restrain any deployable parts of the CanSat.
8	The rocket air frame shall not be used as part of the CanSat operations.
9	The CanSat (Container and Science Vehicle) shall deploy from the rocket payload section.
10	The Container or Science Vehicle shall include electronics and mechanisms to determine the best conditions to release the Science Vehicle based on stability and pointing. It is up to the team to determine appropriate conditions for releasing the Science Vehicle.
11	The Science Vehicle shall use a helicopter recovery system. The blades must rotate. No fabric or other materials are allowed between the blades.
12	All descent control device attachment components shall survive 50 Gs of shock.
13	All descent control devices shall survive 50 Gs of shock.
14	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.
15	All structures shall be built to survive 15 Gs acceleration.
16	All structures shall be built to survive 30 Gs of shock.
17	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.

Requirement Number	Requirement
18	All mechanisms shall be capable of maintaining their configuration or states under all forces.
19	Mechanisms shall not use pyrotechnics or chemicals.
20	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.
21	During descent, the Science Vehicle shall collect and telemeter air pressure (for altitude determination), outside and inside air temperature, flight software state, battery voltage, and bonus objective data (accelerometer data and/or rotor rate).
22	The Science Vehicle shall transmit telemetry at a 1 Hz rate.
23	Telemetry shall include mission time with one second or better resolution, which begins when the Science Vehicle is powered on.
24	XBEE radios shall be used for telemetry. 2.4 GHz Series 1 and 2 radios are allowed. 900 MHz XBEE Pro radios are also allowed.
25	XBEE radios shall have their NETID/PANID set to their team number (decimal).
26	XBEE radios shall not use broadcast mode.
27	The Science Vehicle shall have a video camera installed and recording the complete descent from deployment to landing. The video recording can start at any time and must support up to one hour of recording.
28	The video camera shall include a time stamp on the video. The time stamp must work from the time of deployment to the time of landing.
29	The descent rate of the Science Vehicle shall be less than 10 meters/second and greater than 4 meters/second.
30	During descent, the video camera must not rotate. The image of the ground shall maintain one orientation with no more than +/- 90 degree rotation.
31	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.
32	Each team shall develop their own ground station.
33	All telemetry shall be displayed in real time during descent.
34	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)
35	Teams shall plot data in real time during flight on the ground station computer.
36	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand held or table top antenna.

Requirement Number	Requirement
37	The ground station shall 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.
38	The Science Vehicle shall hold one large raw hen's egg which shall survive launch, deployment and landing.
39	Both the Container and Science Vehicle shall be labeled with team contact information including email address.
40	The CanSat flight software shall maintain and telemeter a variable indicating its operating state. In the case of processor reset, the flight software shall re-initialize to the correct state either by analyzing sensor data and/or reading stored state data from non-volatile memory. The states are to be defined by each team. Example states include: PreFlightTest(0), LaunchWait(1), Ascent(2), RocketDeployment(3), Stabilization(4), Separation(5), Descent(6), and Landed(7).
41	No lasers are allowed.
42	The Science Vehicle shall include an easily accessible power switch which does not require removal from the Container for access. An access hole or panel in the Container is allowed.
43	The Science Vehicle must include a battery that is well secured.. (Note: a common cause of failure is disconnection of batteries and/or wiring during launch.)
44	Lithium polymer cells are not allowed due to being a fire hazard.
45	Alkaline, Ni-MH, lithium ion built with a metal case, and Ni-Cad cells are allowed. Other types must be approved before use.
46	The Science Vehicle and Container must be subjected to the drop test as described in the Environmental Testing Requirements document.
47	The Science Vehicle must be subjected to the vibration testing as described in the Environmental Testing Requirements document.
48	CanSat Science Vehicle and Container must be subjected to the thermal test as described in the Environmental Testing Requirements document.
49	Environmental test results must be documented and submitted to the judges at the flight readiness review.

3.2 Selectable Bonus Objectives

Only one bonus objective can be selected. The points for the bonus objective will only be

awarded if the egg in the Science Vehicle is returned intact.

1.Use a three-axis accelerometer to measure the stability and angle of descent of the Science Vehicle during descent. Sample at appropriate rate and store data for later retrieval.

2.Measure the rotation rate of the auto-gyro relative to the stabilized portion of the CanSat.

3.3 Telemetry Requirements

Upon powering up, the CanSat Science Vehicle shall collect the required telemetry at a 1 Hz sample rate. The telemetry data shall be transmitted as ASCII comma separated fields followed by a carriage return in the following format:

TEAM_ID,MISSION_TIME,ALT_SENSOR,OUTSIDE_TEMP,INSIDE_TEMP, VOLTAGE,FSW_STATE,BONUS

1.The Science Vehicle 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.

2.The telemetry data file shall be named as follows:

CANSAT2015_TLM_<TEAM_ID>.csv

where the <TEAM_ID> is the four digit team id number (e.g., CANSAT2015_TLM_1000.csv)

3.The first line of the CSV file shall be a header line written by the ground software to identify the contents of the file columns. This is needed for the judges to interpret data in the free-form BONUS field.

4.The fields of the telemetry packet are as follows:

a)**TEAM_ID** is the assigned team identification number

b)**MISSION_TIME** is the flight software maintained mission time, in decimal seconds, since CanSat turn-on

c)**ALT_SENSOR** is the altitude as determined with the air pressure sensor with at least one meter resolution

d)**OUTSIDE_TEMP** is the sensed temperature in degrees C with one degree resolution, outside the Science Vehicle structure

e)**INSIDE_TEMP** is the sensed temperature in degrees C with one degree resolution, inside the Science Vehicle structure

f)**VOLTAGE** is the battery voltage

g)**FSW_STATE** is a team-defined indicator of the CanSat flight software state as text or as an integer code (e.g., PreFlightTest(0), LaunchWait(1), Ascent(2), RocketDeployment(3), Stabilization(4), Separation(5), Descent(6), and Landed(7))

h)**BONUS** is free-form bonus objective data (e.g., rotor rate and/or accelerometer data)

i)Additional data fields may be appended after the required fields as determined necessary by the team's design

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 (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.

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.

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 Preliminary Design Review (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 template posted on the CanSat Competition website.

5.2 Critical Design Review

The Critical Design Review (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 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 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 Post Flight Review (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 9AM to the judges. There will be two presentation rooms. Teams will be pre-assigned to the presentation room. Late submissions will lose points.

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 # 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 1021 of version 2 of the PDR package would be named **Cansat2015_1021_PDR_v02.pdf**. Note that adherence to the file name and format

specification is scored during the competition.

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 their mentor a list of three time slots. The mentor will schedule the presentation time and notify the team.

Table 1: Deliverable item due dates

Deliverable:

Material Due	Required Filename Format	Due Date
PDR	Cansat2015_XXXX_PDR_vYY.pdf	02/01/15
CDR	Cansat2015_XXXX_CDR_vYY.pdf	03/29/15
Demo Flight	NA	06/13/15
PFR	Cansat2015_XXXX_PFR_vYY.pdf	06/14/15

XXXX is the team number. YY is the revision number. **Use this file naming format or your team will lose points. Files are to be in PDF format. No other formats will be accepted.** These restrictions are to facilitate automated processing of the presentation files.

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

5.5 Slide Format Guidelines

The following guidelines shall be used when developing the presentation material:
•Use the provided presentation template. 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. Flight Operations

6.1 Schedule

All times are referenced to central daylight time.

The competition starts Friday and ends Sunday evening.

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

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 6:00 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.

All teams shall demonstrate proper operations of their CanSat and ground control station. Each team must demonstrate the capability to 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 flightworthy. The mounting of the electronics and sensors and the sturdiness of wiring harness connections 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 in the Mission Operations Manual. The mission control officer will be identified so the flight coordinator and launch control officer know 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 Mission Operations Manual will be reviewed at the flight readiness review.

In order to have a successful launch, teams need to coordinate among themselves and with the Flight Coordinator. Team members shall be assigned 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 informing the Flight Coordinator know when the team and their CanSat is ready to be launched.

Ground Station Crew - This is one or more persons 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 which 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 on launch day.

6.5 Launch Schedule

The launch will start at 1pm. All CanSats are to be submitted at noon. The time period of 8:00 AM to 12:00 noon is available for launch preparations, check in, and obtaining the Science Vehicle egg. This is the time to assemble antennas and ground stations and to perform final CanSat tests and preparations.

The launch will start at 1:00 PM and will be done in groups of five. Each team will be assigned a launch window which will be scheduled in 1 half hour increments. Be prepared to load rockets toward the end of the previous round.

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:

a)Perform weight check of completed CanSat.
b)Perform fit-check of the CanSat using a sample rocket payload section

Prep and test CanSat for flight.
1.Upon the team round, the team will collect their CanSat and load into a rocket.
2.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.
3.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.
4.The Mission Control Officer will stand at the launch control table and execute the launch procedures with the flight coordinator.
5.Following separation from rocket, team should monitor telemetry during descent.
6.Once all launches have occurred for the hour, the down range will be opened for access to the recovery crew.
7.The recovery crew will locate a field judge out in the field and provide the field judge with the score card.
8.The field judge will score all flight and landing requirements then give permission for the team to recover their CanSat parts.
9.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 anyone 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 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, 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.

Appendix D - Acronyms

A	Analysis
CDR	Critical Design Review
CONOP	Concept of Operations
D	Demonstration
DCS	Descent Control System
FSW	Flight Software
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 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.