



# **The** **Canadian Satellite Design Challenge** ***General Rules & Requirements***

**Presented by:**

The Canadian Satellite Design Challenge Management Society Inc.

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## CSDC Supporters

The Canadian Satellite Design Challenge Management Society Inc. (CSDCMS) would like to acknowledge and thank the following for their support to the CSDC:



The CSDCMS would also like to thank the Canadian Space Agency's David Florida Laboratory.



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### **Acronyms**

CSDC	Canadian Satellite Design Challenge
CDR	Critical Design Review
DIETR	Design, Interface, Environmental, and Test Requirements
EOL	End-Of-Life
FEM	Finite Element Model
ITU	International Telecommunications Union
LEO	Low-Earth Orbit
PDR	Preliminary Design Review
PMP	Project Management Plan
TBC	To Be Confirmed
TBD	To Be Determined
TMM	Thermal Mathematical Model
TRR	Test Readiness Review
UTC	Co-ordinated Universal Time



## Change Record

Date	Version	Changes
Jan. 2011	1a	First Released Version.
Oct. 2014	3a	Changes to the requirements to envelope the requirements of the CalPoly Cubesat Standard, as well as the Nanoracks ICD. Changes to: <ul style="list-style-type: none"><li>• 2.1: Team Eligibility</li><li>• 2.10: Insurance</li><li>• 3.2 Orbit</li><li>• [CSDC-0030] Spacecraft General Design</li><li>• [CSDC-0070] Power Subsystem</li><li>• [CSDC-0085] Timing of Radio Communications</li><li>• [CSDC-0140] Telemetry Time-tag Accuracy</li></ul>





# 1 Introduction

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*This document presents the general rules and regulations governing the participation of university teams in the third offering of the Canadian Satellite Design Challenge, which runs from September, 2014 to May, 2016.*

This document presents the Rules and Requirements for the Canadian Satellite Design Challenge (“CSDC”, or “the Challenge”).

These rules and requirements are applicable to all teams which will be participating in the Challenge, as well as to any faculty or industry advisors who may provide expertise to one or more teams.

## 1.1 Overview

The Canadian Satellite Design Challenge is a Canada-wide competition for teams of university students (undergraduate and graduate) to design and build a small satellite. The satellites will undergo full launch and space environmental qualification testing, with the goal of launching the winning satellite into orbit in order to conduct scientific research.

The CSDC is an innovative and academically-challenging initiative which will advance space education in Canada, inspire students to pursue science and engineering educations and careers, and prepare tomorrow’s leaders with the interdisciplinary teamwork skills which are necessary for success.

For more information regarding the general structure and objectives of the CSDC, please see the “CSDC Overview” document, available on the CSDC web-site ([www.Geocentrix.ca/CSDC](http://www.Geocentrix.ca/CSDC)).

## 1.2 Management and Schedule

The CSDC is managed by The Canadian Satellite Design Challenge Management Society Inc. (CSDCMS), a federally-incorporated not-for-profit organisation, with additional experts and advisors.

The CSDCMS is responsible for all issues regarding technical requirements, team participation, sponsorships and fund-raising, communications and media relations, and government relations (e.g., regulatory requirements).

The planned schedule for this offering of the CSDC is shown in Figure 1.

The programme is intended to run over two academic years, starting in September, 2014. Environmental qualification testing is expected to occur after the completion of the second academic year, in approximately May, 2016.

In order to secure a low-price launch (if the CSDC Management is successful in securing sufficient funding), the programme may have to wait for an appropriate launch opportunity which can accommodate the winning CSDC satellite.

Unfortunately, though, it is not possible to state with any certainty as to when – or if - a launch would occur following the selection of the winning satellite.

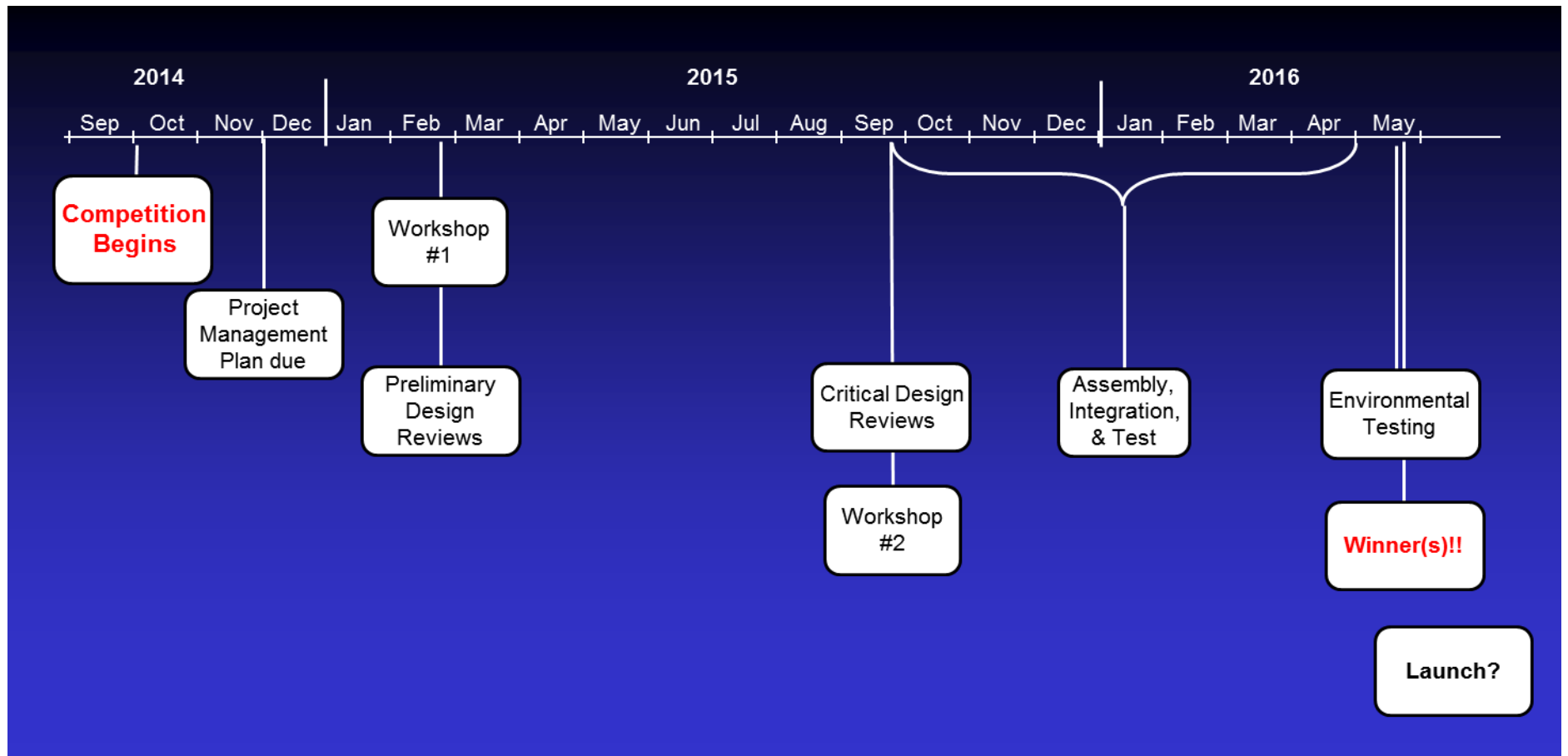


Figure 1. CSDC Schedule.



## 1.3 Interpretation of Rules and Requirements

The CSDCMS will be the ultimate authority with regards to the interpretation of all rules and requirements of the Challenge. Official announcements from the CSDC Management shall be considered part of, and shall have the same validity as, the Rules and Requirements.

Any team may request interpretations of the rules and requirements of the CSDC; however, any questions, and their answers, will be copied to all teams (without revealing the source of the questions).

The wording of statements in this document determines their applicability:

- “**SHALL**” or “**MUST**” are used to indicate a mandatory requirement.
- “**MAY**” indicates an option.
- “**WILL**” indicates a statement of fact or intention.

The section and paragraph headings in this document are provided only to facilitate reading; they do not affect the paragraph contents.

These rules and requirements are subject to change if deemed necessary by the CSDC Management Team.

## 1.4 Point of Contact

The point-of-contact for the CSDC is:

Mr. Larry Reeves, CSDC Manager  
5050 Elgin St.  
Vancouver, B.C. V5W 3J6  
Phone: 778-988-6343  
E-mail: LReeves@CSDCMS.ca

Faculty Co-ordinators, Advisors, or student team leaders only may contact the CSDC Manager regarding any issues or questions about the Challenge and their participation in it.

## 1.5 Reference Documents

The following documents may be applicable to this document, or just for reference. Any conflicts between this document and any of the reference documents, if not noted, should be brought to the attention of CSDC Management.

[AD-1] CSDC Design, Interface, Environmental, and Test Requirements (DIETR), Issue 3.0.

[AD-2] “NanoRacks CubeSat Deployer (NRCSD) Interface Control Document”, Document NR-SRD-029, Revision 0.36, December 10, 2013.  
[http://nanoracks.com/wp-content/uploads/Current\\_edition\\_of\\_Interface\\_Document\\_for\\_CubeSat\\_Customers.pdf](http://nanoracks.com/wp-content/uploads/Current_edition_of_Interface_Document_for_CubeSat_Customers.pdf)

[AD-3] “Cubesat Design Specification”, Rev. 13, Cal Poly SLO, Feb. 20, 2014.  
<http://www.cubesat.org/index.php/documents/developers>





## 2 General Requirements

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The requirements in this Section apply to all participating teams, students, faculty co-ordinators, and team advisors.

### 2.1 Team Eligibility

The Canadian Satellite Design Challenge is open to teams comprised of post-secondary students as follows:

- from one Canadian university; or,
- from two Canadian universities; or,
- from a Canadian and a non-Canadian university; or,
- from a Canadian university and a Canadian college.

Participating universities may enter more than one team in the Challenge; however, each team and its members must be independent of the other, and each entry must be a unique design. If, in the opinion of the CSDC Management Team, there is collaboration between teams or excessive similarity of the designs, the Management Team may declare that only one entry will be permitted.

There is no minimum or maximum number of students which may comprise a team.

### 2.2 Team Member Eligibility

Individual team members must be “degree-seeking” students, i.e., enrolled full-time or part-time in a degree programme at a university, in any faculty or department. Team members may be engaged in co-op work placements or other research projects with a company during their participation in the Challenge, as long as they are considered to be “degree-seeking” students at their university.

The above paragraph applies similarly to participants from a college which teams together with a university: team members must be full-time or part-time students at the college, in a programme which leads to a diploma at that college.

Because the duration of the CSDC will be over two academic years, students who are eligible to be team members for the first academic year of the competition (e.g., final-year students in the September 2014 to April 2015 academic year), may continue as team members even if they graduate or otherwise cease to be a “degree-seeking” student.

A team member may be a member of only one team. A team member may not change teams, or become an Advisor or Faculty Co-ordinator for another team.

Because liability waivers may be required for certain portions of the Challenge, all team members must be old enough to legally enter into a contractual obligation.

### 2.3 Faculty Co-ordinator

Each team shall have a Faculty Co-ordinator. The Faculty Co-ordinator will be considered by competition officials to be a team’s official university or college representative for the purpose of



on-going communications and information regarding the regulations and requirements of the Challenge.

In all other aspects, the Faculty Co-ordinator will have the same role and responsibilities as a Team Advisor.

In order to remove any appearance of conflict of interest, a Faculty Co-ordinator for one team must not become an Advisor or Faculty Co-ordinator for another team during a single instantiation of the Challenge.

The Faculty Co-ordinator shall sign a “CSDC Declaration of Compliance”, given in Appendix A.

## 2.4 Team Registration

In order to register for the CSDC, a team representative (student or faculty) should notify the CSDC Manager, by September 30, 2014, of their intention to participate.

The notification to the CSDC Manager shall identify:

- the name and contact information (e-mail and phone number) of the Faculty Co-ordinator;
- the name and contact information (e-mail and phone number) of one or two primary student contacts for the team (if determined at that time);

The CSDC Management Team will acknowledge the registration.

## 2.5 Registration Fee

There is no fee to enter a team into the Challenge.

## 2.6 Team Advisors

Each team may use any number of Advisors, e.g., from space industry companies, university faculty, or elsewhere.

Faculty Co-ordinators or Industry Advisors may advise their teams on general principles of space missions, engineering, and project management theory, but may not design, fabricate, or assemble any part of the spacecraft, or prepare any documentation or design review presentation material (although participating in presentations to the public is permissible and encouraged).

In summary, the satellite must be designed and built by the student team members without direct involvement from any non-team-member(s). There are two potential exceptions to this requirement:

- An advisor may intervene where a design decision which the team makes is certain or likely to lead to spacecraft failure or a safety hazard; and,
- An advisor may perform specialised analyses, instruction, software programming, or other assistance, on the strict condition that the assistance is authorised by the CSDC Manager in advance and does not require more than 20 (TBC) hours of effort.



In order to remove any appearance of conflict of interest, an Advisor for one team must not become a team member of, or an Advisor or Faculty Co-ordinator for, another team during a single instantiation of the Challenge.

## **2.7 Design Originality**

Any spacecraft designed and presented for the CSDC must be an original design, the configuration of which is conceived by the student team members alone.

Team members may use any publicly available literature or knowledge related to spacecraft design and construction.

Teams are welcome to collaborate with one or more professors, companies, or research institutions, on ideas for payloads. A team can accept an entire payload instrument from any of the above, and incorporate it into the spacecraft. The payload provider can provide only operational and interface requirements for proper use of the instrument, and must not contribute to the design of the bus systems which mount or operate it.

## **2.8 Compliance to the Rules and Requirements**

By entering a team into the Challenge, the team, individual members of the team, faculty and industry advisors, and any other associated personnel, shall comply with, and be bound by, the letter, spirit, and intent of the CSDC Rules and Requirements, and all interpretations or procedures issued or announced by the CSDC Manager. All student team members, faculty or industry advisors, and other university or college representatives shall co-operate with, and follow all instructions from, the CSDC Manager.

Teams are responsible for reading and understanding the Rules and Requirements for the Challenge. Failure to do so may result in a team being disqualified from participation in the Challenge.

## **2.9 Official Languages**

The official languages of the CSDC are English and French.

Design reports, review presentations, correspondence with the CSDC Manager, or other documentation, shall be prepared in one of these official languages.

## **2.10 Insurance**

In order to participate in some CSDC events (e.g., environmental testing at the David Florida Laboratory), teams may be required to demonstrate that they have third-party liability or Commercial General Liability coverage from their respective universities. A minimum of CAD \$2,000,000.00 is recommended (and may be required).



## 3 Mission and Spacecraft Requirements

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### 3.1 Mission Requirements

#### [CSDC-0010] Mission Purpose

Each team shall set a mission purpose for their spacecraft.

**Comment:** Teams are free to decide what payload instrument(s) or experiment(s) they wish to incorporate into their spacecraft in order to meet their mission purpose and goals.

### 3.2 Orbit

Teams should design their missions to be able to operate in a Low-Earth Orbit (LEO), between 400 km and 800 km. Other orbits (including interplanetary) can be proposed, with the understanding that the probability of securing a launch beyond LEO diminishes dramatically.

At the time of the release of this document a launch has not been procured, and more specific orbit parameters cannot be given; thus, it is advantageous to have a mission and satellite design which can operate in both a sun-synchronous orbit (at different Equator Crossing Times) and in the orbit of the International Space Station (ISS).

#### [CSDC-0020] Orbit Knowledge

It shall be possible to determine the spacecraft's orbit parameters throughout the mission, to an accuracy as required by the mission.

### 3.3 Spacecraft Requirements

#### [CSDC-0030] Spacecraft General Design

The spacecraft shall be designed to accomplish its mission purpose and to maintain spacecraft health during the design lifetime of the mission.

The spacecraft shall be passive and self-contained (i.e., electrically OFF, no charging of batteries, no telemetry, and no other support) from the time it is loaded into the launch dispenser until after its deployment on-orbit. This may encompass a duration of several months.

#### [CSDC-0040] Spacecraft Design Life

The spacecraft shall be designed for a nominal mission lifetime of one year.



#### **[CSDC-0050] Design for End-of-Life**

The spacecraft shall be designed such that all requirements are met at nominal End-of-Life (EOL).

#### **[CSDC-0060] Comply with DIETR**

The spacecraft shall comply with all requirements of the “CSDC Design, Interface, Environmental, and Test Requirements” (DIETR) [AD-1].

#### **[CSDC-0070] Power Subsystem**

The spacecraft shall incorporate sufficient power generation and power storage capability to support all operational states and modes during the design lifetime of the mission. More specific requirements for the Power system are given in the “CSDC Design, Interface, Environmental, and Test Requirements” (DIETR) [AD-1].

#### **[CSDC-0080] Comply with ITU Regulations**

The spacecraft shall comply with the International Telecommunications Union (ITU) applicable radio licensing regulations for the required Radio Frequency operations.

#### **[CSDC-0085] Timing of Radio Communications**

The spacecraft shall not generate or transmit any radio signal from the time of integration into the launch dispenser until at least 45 minutes after on-orbit deployment; however, the spacecraft can be powered ON immediately following deployment.

#### **[CSDC-0090] Spacecraft Commanding**

The spacecraft shall have the ability to receive and execute immediate or time-tagged commands.

#### **[CSDC-0100] Command Storage**

The spacecraft shall have the ability to store time-tagged commands for up to seven days prior to executing them.

#### **[CSDC-0110] Safety-critical Commands**

Any safety-critical or deployment commands shall be implemented as a two-step process.

**Comment:** *This means that at least two separate commands must be sent in order to activate the deployment. Ideally at least one of the commands will be sent from the Control station during a pass, but this is not always possible (e.g., for antenna deployment).*

#### **[CSDC-0120] Spacecraft Telemetry**

The spacecraft shall record at least four different points of spacecraft health telemetry, each at a frequency of at least one sample every five minutes.



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**[CSDC-0130] Spacecraft Telemetry to be Time-tagged**

The spacecraft shall time-tag all telemetry data.

**[CSDC-0140] Telemetry Time-tag Accuracy**

Deleted.

**[CSDC-0150] Telemetry Downlink Latency**

Under nominal operational conditions, the spacecraft shall have the ability to downlink telemetry data with a latency of less than 12 hours from when it was recorded.

**[CSDC-0160] Payload Data Downlink**

Under nominal operational conditions, the spacecraft shall have the ability to downlink all acquired payload science data which is required to meet its science objectives.

**[CSDC-0170] Attitude Determination Fault-tolerance**

The Attitude Determination subsystem shall be designed so that it is tolerant to at least one attitude sensor failure, and will maintain at least a degraded state of performance.

**[CSDC-0180] Attitude Control Fault-tolerance**

The Attitude Control subsystem shall be designed so that it is tolerant to at least one attitude actuator failure, and will maintain at least a degraded state of performance.

**[CSDC-0190] Exportable Technology**

The spacecraft shall only contain components which can be exported from Canada to any of the following countries without restrictions: India, Russia, United States, French Guyana.

## **3.4 Ground Segment and Operations Requirements**

**[CSDC-0200] Ground Segment Hardware**

The winning team shall provide a computer which will be used for spacecraft operations (i.e., to contain any mission planning, monitoring, and analysis software). The CSDC Management will provide the necessary Ground Segment hardware, consisting of the transmit/receive antennas, and any required antenna controller hardware, in order to communicate with the spacecraft during passes. The Ground Segment hardware provided by the CSDC Management will remain the property of the CSDC Management.

**[CSDC-0210] Spacecraft Operations Facility**

The winning team shall be responsible for providing a suitable location for the Ground Segment hardware (i.e., the transmit/receive antenna(s), any required antenna controller hardware, and the spacecraft operations computer hardware).





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**[CSDC-0220] Spacecraft Operations Costs**

The winning team shall be responsible for any costs associated with maintaining and operating their operations facility.

**[CSDC-0230] Spacecraft Operational Lifetime**

The winning team shall be responsible for the operation of the spacecraft (consisting of mission and operations planning, command uplink transmission, data and telemetry downlink reception, and data storage and distribution) for a period of at least one year following launch.

The winning team may continue spacecraft operations past the one-year period, at their discretion and cost. Extended use of the ground segment hardware provided by CSDC Management will not be unreasonably withheld.

**[CSDC-0240] Network Operations Facilities**

The winning team may permit any other participating university to establish an operations facility for the purpose of performing any aspect of spacecraft operations. The CSDC Management will provide any requested information about the Ground Segment; however, the CSDC Management will not provide any hardware, and will not be responsible for any associated costs, for any additional operations facilities.



## **4 Programmatic Requirements**

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### **4.1 Documentation and Analyses**

#### **4.1.1 Project Management Plan**

##### **[CSDC-0300] Project Management Plan**

Each team shall prepare and submit a Programme Management Plan (PMP) to the CSDC Manager for review.

The CSDC Manager will distribute specific details regarding the format and content of the PMP.

#### **4.1.2 Mechanical Modelling and Analyses**

##### **[CSDC-0310] Finite Element Modelling and Analysis**

Each team shall create a Finite Element Model (FEM) of their spacecraft. This model will be used to perform structural analyses to show compliance to the mechanical loading requirements, and as a prediction for environmental testing. The specific requirements for the FEM and analyses are currently TBD, and will be released separately.

#### **4.1.3 Thermal Modelling and Analyses**

##### **[CSDC-0320] Thermal Mathematical Modelling and Analysis**

Each team shall create a Thermal Mathematical Model (TMM) of their spacecraft. This model will be used to perform thermal analyses to show compliance of the design to the mission thermal environment, and as a prediction for environmental testing. The specific requirements for the TMM and analyses are currently TBD, and will be released separately.

### **4.2 Design Reviews**

#### **4.2.1 Preliminary Design Review**

##### **[CSDC-0330] Preliminary Design Review**

Each team shall prepare and submit a Preliminary Design Review (PDR) package, in order for the CSDC Management Team to review the initial design and analyses of their mission and spacecraft.

The teams will present the details of their design to date to show that they fully understand all of the requirements, and have created a design which is feasible and will be able to meet the requirements. The teams will also demonstrate that they have a



good understanding of the process which will be required to build the satellite as designed.

The CSDC Management Team reviewers may request additional analyses or details which must be prepared in time for the Critical Design Review, or may make recommendations to the team to assist their efforts.

The possible outcomes of the PDR include pass, conditional pass, or fail. In the event a team is considered to have failed the PDR, it may be recommended that the team withdraw from the Challenge. In the event a team receives a conditional pass, the team will be required to complete specific actions identified by the reviewers in order to continue with the Challenge.

In advance of the PDR, the CSDC Management Team will prepare and distribute specific details regarding the format and content of the material to be presented.

It is currently foreseen that for PDR teams will only be required to submit the required documentation, which will be reviewed by the CSDC Management.

#### **4.2.2 Critical Design Review**

##### **[CSDC-0340] Critical Design Review**

Each team shall prepare and submit a Critical Design Review (CDR) package, in order for the CSDC Management Team to review the final design and analyses of their mission and spacecraft.

The teams shall present the final spacecraft design, documentation or analyses which were requested arising from PDR, and the facilities and process to build and test the satellite and prepare for Space Qualification Testing.

The possible outcomes of the CDR are either pass or fail. In the event of a pass, the CSDC Management Team reviewers may still request additional documentation or make recommendations to the team, to assist them in the manufacturing stage.

In the event of a fail, it may be recommended that the team withdraw from the Challenge and not proceed with the manufacturing stage.

In advance of the CDR, the CSDC Management Team will prepare and distribute specific details regarding the format and content of the material to be presented.

The location of the CDR is TBD. It is likely that representatives from a team (faculty advisor and two or three students) will have to travel in order to give their CDR presentation. Teams shall budget for the travel costs associated with attending CDR. For planning purposes, the teams can assume that the CDR will take place in either Toronto, Ottawa, or Montreal.

### **4.3 Spacecraft Environmental Test Campaign**

The Spacecraft Environmental Testing Campaign will proceed as described in the “CSDC Design, Interface, Environmental, and Test Requirements” (DIETR) [AD-1].



#### **4.3.1 Test Readiness Review**

##### **[CSDC-0350] Test Readiness Review**

A Test Readiness Review (TRR) will be held prior to the Environmental Qualification Test campaign, at which each team shall demonstrate that their spacecraft has been fully constructed per their design presented at the Critical Design Review (including any permitted post-CDR changes), and is ready to proceed to environmental qualification testing.

In advance of the TRR, the CSDC Management Team will prepare and distribute specific details regarding the format and content of the material which is to be presented.

#### **4.3.2 Environmental Qualification Testing**

Details of the environmental qualification test campaign are given in the “CSDC Design, Interface, Environmental, and Test Requirements” (DIETR) [AD-1].

### **4.4 Spacecraft Final Selection**

The CSDC Managing Body will review all relevant documentation and test results to select one or more winning satellites, based on the CSDC Judging Criteria.



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## 5 Other Requirements and Issues

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### 5.1 Intellectual Property

#### **[CSDC-0400] Ownership of Science Data and/or Intellectual Property**

Ownership of any Science Data or Intellectual Property arising from a team's participation in the CSDC shall be consistent with the policies in place at their university.

No claim on any resulting Intellectual Property will be made by the CSDCMS or any other entity affiliated with the CSDC (e.g., sponsors or advisors' companies), unless covered by a separate pre-existing agreement.

#### **[CSDC-0410] Provision of Science Data**

Notwithstanding any policies and/or agreements which may affect any participating university team, the winning team agrees that it shall provide the science data to any participating team which requests it, after a period of one year following the date of downlink.

### 5.2 Educational Outreach

#### **[CSDC-0500] Educational Outreach Requirements**

Among the many objectives of the CSDC are the following:

- to motivate and inspire pre-university students to pursue science and engineering educations, which can lead to one of a multitude of challenging and rewarding space-related careers or research positions.
- to highlight the benefits and importance of satellites and space for Canadians.
- to increase public awareness and interest in the applications of satellite missions, and the importance of satellites and space for Canadians.

To that end, at least once per academic year (2012/13 and 2013/14), each team shall be required to give presentations to a variety of audiences:

- at least one presentation to an elementary school; and,
- at least one presentation to a secondary school; and,
- at least one presentation open to their university campus; and,
- at least one presentation to the general public in the university's town/city (off-campus); and,
- at least one presentation to a sponsoring/participating company or professional organisation (e.g., professional engineering association).

The presentation can combine topics of:

- general satellite applications
- Canadian space mission history
- satellite design, particularly their team's satellite design and purpose



- applications/importance/benefits of satellites for Canadians
- science and engineering education disciplines involved in space missions

Teams are encouraged to distribute the responsibility of giving the presentations among as many team members as possible, rather than having the same few members give all presentations.

Each team's Faculty Co-ordinator shall verify that the team has met this requirement. This requirement shall be met by the start of the Environmental Test Campaign.





# Appendix A:

## CSDC Declaration of Compliance

*To be completed by the team's Faculty Advisor*

Name (print): \_\_\_\_\_

University: \_\_\_\_\_

Mailing Address: \_\_\_\_\_

\_\_\_\_\_

e-mail: \_\_\_\_\_ Phone: \_\_\_\_\_

I declare that I am the Faculty Co-ordinator for the above-mentioned student team which is entered in the Canadian Satellite Design Challenge.

I declare that, to the best of my knowledge and ability, I will ensure that the above-mentioned team:

- will adhere to the letter, spirit, and intent of the CSDC Rules and Requirements;
- will design and construct their team's satellite entirely on their own, and will prepare all presentation material entirely on their own, without direct assistance from myself or from any other faculty or industry advisors, except as permitted by the Rules and Regulations.

The involvement of myself and other Faculty or Industry advisors with the team has served only to provide guidance to the team in order to allow them to reach decisions on their own, without any specific direction or decision-making by us.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_