LAUNCH CANADA CHALLENGE

Rules & Requirements Guide

Revision History

REVISION	DESCRIPTION	DATE
R0	Initial Release	4-Nov-19
R1	Initial Design Proposal and Project Progress Report due dates revised	19-Dec-19
R2	Updated Content for 2021	6-Nov-20
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R4	Updated Content for 2023	3-Oct-22
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1.0 INTRODUCTION

The Launch Canada Challenge is Canada's premier national rocket competition, supporting the development of talent in the interdisciplinary field of rocket engineering, while fostering a strong culture of safety. It includes two launch challenges as well as a technology development challenge for component and subsystem-level technologies. The competition aims to be a flexible, adaptable framework to support innovation across the full range of rocket and launch-related technologies, and actively works with stakeholders to create challenges that solve real industry problems. Through national collaboration, this competition provides a local launch opportunity for Canadian students, encourages innovation across the multidisciplinary field of rocketry, and helps Canada's advanced rocketry community to take their activities to the next level.

1.1 BACKGROUND

In over 20 universities across Canada, teams of passionate and committed students are leading the world in developing sophisticated rocket technology and participating in innovative ways to develop amateur sounding rockets. The Launch Canada Challenge provides an opportunity for these students to present, test and demonstrate their best work in aerospace engineering and launch vehicle-related technology within Canada. This national competition rewards the initiative of these teams and their commitment to space technology and engineering excellence, and provides them with an unmatched, real-world learning experience that will help place them in the top tier of young engineering talent.

With backing from its visionary sponsors across diverse industries, Launch Canada helps channel the passion and develop the skills of young scientists and engineers in the cross-disciplinary field of rocket engineering.

1.2 PURPOSE AND SCOPE

This document defines the rules and requirements governing participation in the Launch Canada Challenge. The guidelines provided in this document are intended to help teams adhere to the highest safety standards, to promote innovation and learning, and uphold Launch Canada's mission. This document provides key information regarding the competition challenges, code of conduct, procedures, timeline, expected deliverables and general guidelines for teams to refer to. This document is not a detailed guide for the technical requirements for the Launch Canada Challenge. A detailed overview of the technical requirements can be found in the ***Launch Canada Design, Test and Evaluation Guide (DTEG)***, provided by Launch Canada via its webpage. This document is not a detailed guide for how judging and scoring is conducted for the Launch Canada Challenge. A detailed overview of the judging process, including the scoring rubrics used to assess each team, titled the ***Launch Canada Judges Handbook***, will be provided on the Launch Canada webpage.

Should there be any questions or concerns regarding the information provided in this document, teams are encouraged to reach out to the organizers for support.

1.3 REVISION

It is expected the *Launch Canada Rules & Requirements* document may require revision from one competition to the next, based on the experiences and lessons learned by both host organizations and the participants. Major revisions will be accomplished by complete document reissue. "Real world events" may require smaller revisions to this document in the months leading up to a competition. Such revisions will be reflected in updates to the document's effective date. The authority to issue revised versions of this document rests with Launch Canada.

2.0 LAUNCH CANADA COMPETITION OVERVIEW

With the goal of helping students develop their skills in rocketry and boosting the aerospace industry in Canada, Launch Canada has different challenge levels for teams to choose from. The aim is for students to demonstrate their ability to develop requirements and engineer real aerospace systems that meet them, whether that system is a component or an entire rocket vehicle. There are three main challenge categories as listed below. A common goal of all three challenges is to cultivate an understanding of good systems engineering practices that can help a team to be successful in taking on complex aerospace problems. As a result, teams are expected to formally define the requirements for their project, including target altitude, and they will be judged on their complete engineering design, development and testing process, and on how effectively the final product meets the requirements for which it was designed.

- **Basic:** A launch and recovery challenge for single-stage vehicles using commercial off-the-shelf (COTS) rocket motors, with a target apogee of at least 10,000 feet. This challenge is geared towards both new teams just getting started in advanced rocketry, as well as more experienced teams that want to flight test new technologies for the first time using off-the-shelf propulsion systems.

- **Advanced:** A challenge for rockets using student researched and designed (SRAD) liquid or hybrid propulsion system, or complex (e.g., multi-stage) solid propulsion. This challenge is particularly geared towards teams with more experience that wish to create more complex rockets and undertake their own propulsion system development. A rocket is fundamentally a complex aerospace system, and this category focuses on rigorous systems engineering.

- **Technology Development Challenge:** A flexible challenge aimed at rocket component or subsystem design and development. For teams with specialized expertise, those wanting to take their ideas to the market or teams who wish to perform new research and take a “deep dive” into specific areas of rocket technology. This category is designed to promote an in-depth understanding of key rocket technologies, allow more student-industry interaction, and provide the freedom for teams to pursue areas of rocket technology that they are interested in learning more about. Any rocket-related technology may be entered into the technology development challenge, so long as the project complies with Canadian law. Launch Canada reserves the right to reject a proposed project if there are safety or legal concerns with any aspects of it. In addition to the technology itself, teams must show an understanding of the context that their technology fits in, and part of the score will come from presenting that context and considering the business case. This will be evaluated both through reports, and through a final presentation to the judges at the competition itself.

SRAD propulsion systems are defined as those designed by students – regardless of whether fabrication is performed by students directly, or by a third party working to student-supplied specifications – and also includes student designed modifications of COTS systems.

Multistage launch vehicles and all chemical propulsion types (solid, liquid, and hybrid) are allowed. Note that all propellants used must be “non-toxic”. Ammonium perchlorate composite propellant (APCP), potassium nitrate and sugar (aka "rocket candy"), nitrous oxide, liquid oxygen (LOX), hydrogen peroxide, kerosene, ethanol and propane are all considered non-toxic. Toxic propellants are defined as those requiring breathing apparatus, special storage and transport infrastructure, extensive personal protective equipment, etc. (e.g., Hydrazine and N_2O_4).

Note that there is no firm upper limit on the target apogee for the advanced category. This is specifically done to encourage teams to define their own target and engineer a system to meet that target through careful

analysis, simulation, testing, and potentially the use of control systems. Nonetheless, there will be practical altitude caps imposed by the launch site. For any teams that wish to target an altitude greater than 35,000 feet AGL, Launch Canada's approval will be required and much more detailed trajectory modeling will be required.

There is considerable freedom for teams to create unique and impressive rockets, however for the sake of safety and logistics of recovery there are basic technical requirements and standards that must be complied with. These can be found in the *Launch Canada Design, Test and Evaluation Guide* (DTEG) document. All participating teams are expected to be familiar with the DTEG.

2.1 TEAM COMPOSITION AND ELIGIBILITY

2.1.1 STUDENT TEAM MEMBERS

Teams entering the competition will be undergraduate or graduate run student teams. These teams may have any educational background and may consist of any number of students. However, due to constraints at the launch site, teams may be asked to limit the number of participants they bring to the site of the competition itself.

Teams are encouraged to assign members to specific roles and may structure their teams how they see fit. However, at minimum 3 student roles and 1 faculty role are required. Specific names must be entered into these 4 roles for the team entry to be complete. The required roles are:

- **Faculty Advisor**: a faculty or staff member of the university who provides official oversight of the team.
- **Team Captain**: a team member who is responsible for leading the team.
- **Chief Engineer**: a team member responsible for overseeing and coordinating the engineering activities of the project. They are responsible for managing the project requirements, flowing them down to the sub teams doing the work, and ensuring the final design meets the requirements.
- **Chief Safety Officer**: a team member with overall safety responsibility. They are responsible for working with their team to identify the safety hazards associated with the team's project and activities and ensure those hazards are mitigated through design, training, operations, and the proper use of protective equipment.

Teams are free to adopt whatever management structure and roles they choose, but there must be people who fill the above functions and it should be made clear to Launch Canada who is responsible for each of these functions. Additionally, in support of active outreach and building the talent pipeline, teams may invite certain individuals from local high schools or community colleges to join the university team. Such individuals must be listed on their team roster and this roster list submitted to Launch Canada. If the individual is under 18, a signed parental consent form must also be submitted. These apprentice team members may not comprise more than 15% of the team composition.

2.1.2 TEAM ORGANIZATION AND SUBMISSION LIMITATIONS

Teams may participate in one or both of the launch categories, but they may not compete in both launch challenges with the same rocket. Should a given team choose to enter different rockets into separate launch challenges they may do so. It is however permissible for a team to simultaneously enter a launch category and a technology development category, if the launch is used as a flight demonstration of the technology.

If a team joins the competition with the intent of competing in a given category but decides over the course of the year that they wish to change it, this change may be permitted until the Final Design Report is submitted. Teams must notify Launch Canada of any planned category changes as early as possible.

If a team is entering with more than one project, they must submit a separate entry form ***for each of their projects***. Separate deliverables will also be expected for each of the entries, including the design presentations and final reports.

2.2 OUTREACH, DIVERSITY AND INCLUSION

Aerospace and rocketry have always had a powerful ability to inspire and motivate people to take on difficult problems and pursue excellence. We know that diversity is one of our greatest strengths and that Canadians from all backgrounds and in all places have limitless potential to accomplish amazing things. One of Launch Canada's goals is to ensure that Canadians from coast to coast have the opportunity to take part and harness that inspiration.

Student teams have been the "front line" for Canadian rocketry, and all teams are strongly encouraged to be ambassadors for Canadian rocketry and pursue an active and creative outreach program to build links in their own communities and beyond in order to:

- Build awareness of science, technology, engineering and mathematics (STEM), aerospace, and rocketry in particular;
- Showcase the work and accomplishments of the team, and the value of Canadian rocketry and space;
- Encourage the next generation of Canadians to pursue rocketry and STEM, including especially those from traditionally under-represented communities.
- Include all Canadian communities, from urban to remote, in the nation-wide effort to explore and develop space.

Teams will be evaluated in part based on the scope, creativity, and demonstrated effectiveness of their outreach programs in meeting the above goals. Many paths exist to accomplishing this effectively, but Launch Canada strongly encourages the following as a blueprint to build upon:

In general, teams should have a formal outreach program led by at least one team member overseeing outreach activities as part of their management team (as partial or full responsibility).

In terms of communication with the public, the teams are encouraged to have a social media platform (or more) on which they openly share updates regarding their development efforts and competition attendance. The teams can also leverage funding opportunities with their institution or governmental organizations to be able to share their progress on national and international platforms through conferences (IAC, SSC, etc.), webinars, tabling events (AstroFest, etc.) and more. It is also recommended that all team members understand holistically the technology their team is presenting to competition (with a focus on recent advances) so that they can explain and communicate their technology to other teams and layman audiences from school children to seniors.

To ***promote the education and awareness of the public in the STEM fields***, teams are encouraged to prepare at least one educational activity linked to their technology for members of the public visiting the Launch Canada competition, that are accessible to a layman audience of all ages. If they develop innovative technology during the year, Launch Canada also encourages teams to share a short-form 15-minute presentation on the topic for the conference section of the competition to share their newly acquired knowledge openly with the local community.

Launch Canada teams are similarly advised to hold such presentations and similar events throughout the development year to educate and spread knowledge about rocketry and STEM to their local communities across Canada.

Inclusivity, Education and training can also be embodied through sharing between teams! More experienced Launch Canada team members are encouraged to provide support and guidance for younger, less experienced teams attempting technical challenges (e.g., test site development and safety procedures). Not all teams have equal resources, thus sharing knowledge and helping each other can be a great way to bridge these uneven foundations and help grow a safer, more sustainable, equitable and, overall, exciting rocketry field in Canada.

Finally, to uphold the ***highest degree of inclusivity, respect and cultural awareness***, teams must remember that when they attend competition, they are guests in a community that is generously hosting us, and their actions and interactions with members of the community reflect on Launch Canada. All attendees should inform themselves of the local customs of the community in which the Launch Canada Competition is taking place and conduct themselves in a respectful and culturally sensitive manner.

All of these are ways to contribute to a longer-term vision of the Canadian student rocketry field and thus are elements that can contribute to a high outreach score at the Launch Canada competition.

2.3 MENTORSHIP

Rocketry is a complex, specialized and highly multidisciplinary field of engineering and tends to involve a steep learning curve, particularly for newer teams, or those branching out into advanced areas such as experimental propulsion. As in industry, experience can go a long way towards ensuring that teams are safe and successful, and helping them avoid common "rookie mistakes" that can come from inexperience, while a lack of experience is a very common cause of launch delays, last-minute rework or failures at competition. As a result, it is **very strongly recommended** that teams seek out one or more mentors with relevant experience to provide guidance and help them to avoid the more common pitfalls that can come from a lack of experience. Typical Launch Canada rockets have a lot of overlap with the more advanced end of hobby high power rocketry (HPR), and both in Canada and internationally there is an active community of experienced individuals who are knowledgeable about practices such as airframe and fin design and construction, recovery system design, avionics and telemetry, etc. These people will often be members of rocketry organizations such as the Tripoli Rocketry Association (TRA), Canadian Association of Rocketry / Association Canadienne de Fuséonautique (CAR/ACF), or National Association of Rocketry (NAR). Launch Canada teams are strongly encouraged to seek out such individuals to serve as a mentor, preferably one from the local area who is able to work directly with the team.

Launch Canada staff are also happy to provide their feedback to teams over the course of the year, both in the context of official competition deliverables and upon request to support design reviews, etc. But there is often no substitute for somebody local who can work directly with the team on an ongoing basis.

For teams who lack a mentor, Launch Canada is happy to help find a suitable individual.

2.4 PAYLOADS

A rocket's ultimate purpose is to carry a payload that performs a useful function, and Launch Canada teams are strongly encouraged to develop and fly an innovative payload as part of their project. With its partners, Launch Canada offers a Payload Challenge for teams that develop and fly a payload, Details of the payload challenge will be provided separately, and payloads will be evaluated as a separate technology. This will be based on function and scientific value of the experiment. The payload challenge is not however a stand-alone challenge. Those who wish to enter the payload challenge must do so with the intent of launching their payload with the rockets entered into the competition.

There will be no penalties for choosing not to fly a payload, but there will be bonus points available for flying

one. If this payload does enhance rocket performance or improve any other rocket function, this may be considered a rocket technology as opposed to just a payload. There are no specific constraints on payload envelope or weight, but teams are strongly encouraged to follow good systems engineering practices to ensure the vehicle design properly accounts for the payload, and the payload in turn respects the constraints provided by the vehicle.

As with the rocket itself, the choice of payload is flexible and the goal is to successfully fly a payload that achieves its predetermined goals, not just one that fits within an arbitrary category description. The payload should focus on design and proper implementation of scientific principles.

Payloads shall not contain significant quantities of lead or any other hazardous materials. Similarly, any use of radioactive materials shall be permitted only if deemed operationally necessary and such operational necessity is concurred with by competition officials. If approved, any such materials shall be fully encapsulated and are limited to 1 μC or less of activity. Finally, payloads shall not contain any live, vertebrate animals.

2.5 TOTAL IMPULSE LIMITATION

There is no specific restriction imposed on the thrust level or total impulse of the rockets entered into Launch Canada. Teams are however strongly encouraged to keep their total impulse within the definition for FAA Class 2 (i.e., having a combined total impulse of 40 960 Ns (9 208 lb-s) or less). Rockets having a total impulse greater than this are contingent on approval by Launch Canada. In addition, there may be other propulsion restrictions listed and it would be pertinent to refer to the *Launch Canada Design, Test and Evaluation Guide*.

2.6 ROCKET TRACKING AND TRANSMISSIONS

All parts of the rocket that are intended to be recovered separately (i.e., separate multistage parts, deployed payloads, etc.) need to have a COTS tracking device incorporated into them. This should allow teams to track and recover all components. The COTS system may be the primary or back up system, but its presence is required. Teams will be required to announce the frequency of any radio devices on their vehicle and ground support equipment. Teams may choose to transmit on a Canadian license-exempt frequency band (e.g., the 33 cm (902-928 MHz) band). Use of the 70 cm (430 – 450 MHz) or APRS is also permitted, but as these frequencies require an amateur radio (HAM) license, the team must have at least one member present at the event who is suitably licensed.

2.7 OFFICIAL ALTITUDE LOGGING

Teams are required to prove that their altitude matches that which the rocket was designed for and simulated to achieve. For this purpose, all rockets must carry a COTS barometric altimeter with on-board data storage, which will provide an official log of apogee for scoring. This may be a standalone COTS product, or a feature of a COTS flight computer, for example one used for recovery system deployment. If the project features a deployable payload, the official altitude logging device shall be mounted to the launch vehicle and not the payload.

At the launch site, there will be a designated Data Recovery Station, and a competition official responsible for downloading flight data. All rocket recovery teams must report directly to the Data Recovery Station once they return after recovering their rocket, and they must bring any necessary equipment to download the recovery data (e.g., laptop and cables). Some altimeters are designed to report apogee through a series of beeps, but beeps shall NOT be accepted except as a last resort. Failure of a team to report directly to the Data Recovery

station for flight data download may lead to penalties.

2.8 POST FLIGHT REPORTS

As the final deliverable of the competition cycle, Launch Canada teams are requested to provide a brief post-flight report, regardless of whether the flight was successful or not. The report should be submitted as soon after the competition as possible, and this report must be received before the team will be permitted to register for the following year's competition. This report is meant to serve as a record of the team's operations and flight at the competition and a comparison to the team's predictions. It is also intended to summarize any problems or anomalies that arose during setup or flight operations, and to identify the lessons learned and changes that will be made. This information provides an important record for the teams to preserve for future years, while also helping Launch Canada identify problems that might be addressed through our own standards, training, and event planning. It also helps us demonstrate to government bodies that we as a community are constantly learning and improving based on our collective experience. Content in each post flight report must include:

- **Executive Summary:** Give a quick overview of the launch, including setup, flight, key flight data, and any problems, mishaps or failures that occurred. If a launch failed to occur, summarize what happened to prevent the launch. Discuss the determined root causes of any such problems, and summarize any changes you'll be making next time to address them.
- **Overview of Preflight Operations:** Summarize your setup and prelaunch activities. If any problems came up that caused delays or prevented your launch, discuss them, what you learned, and what you'll be doing differently next time. This can include technical/hardware issues, but can also include operational issues relating to planning or preparedness shortcomings.
- **Overview of the Flight:** Summarize your flight data, actual apogee, and a description of nominal and off-nominal flight events. Provide photos where appropriate.
- **Recovery Location:** Provide details of the recovery location (GPS coordinates), and comparison of the actual recovery point with your predictions from simulation.
- **Recovery Operations:** Description of the recovery operation, ideally including photos: how did you find the rocket, were there any challenges in locating it or reaching it, and did you learn any lessons to improve location and recovery in the future? Provide photos of any damage sustained to the rocket.
- **Failure Investigation:** If something went wrong, describe what happened. Include photos and other details to clearly document it. Present the analysis of the root cause of the failure using the available data, as far as possible, and explain any changes you'll be making in the future to your design, manufacturing, testing and/or operations to prevent the failure next time.

2.9 PROJECT DELIVERABLES

To participate in the competition and to allow for the evaluation of the project as it progresses, teams will have several deliverables to submit. This includes the following:

DELIVERABLE	DUE DATE	HOW TO SUBMIT
Entry Form and Participant Clearance	13 October, 2023	Online form
2022-2023 Post Flight Report (for LC2023 participants)	13 October, 2023	competition@launchcanada.org
Initial Design Proposal	10 November, 2023	competition@launchcanada.org
Initial Presentations	11-26 November, 2023	Online signup form
Project Technical Reports, Forms and Deliverables		
Preliminary Design Report	26 January, 2024	competition@launchcanada.org
Project Progress Report	24 May 2024	competition@launchcanada.org
Site Plan (for Advanced Launch or Tech)	24 May 2024	adam@launchcanada.org
Engine Static Test Firing Request	Prior to engine testing	adam@launchcanada.org
Final Project Report	22 July, 2024	competition@launchcanada.org
Virtual Inspections	Minimum 2 weeks prior to competition	Online signup form
Ops Rehearsal (for Advanced Launch)	Minimum 2 weeks prior to competition	Email adam@launchcanada.org to schedule
Design Deviation Form	At competition event check-in	adam@launchcanada.org
Additional Documents		
School Participation Letter	12 July, 2024	events@launchcanada.org
School Insurance	12 July, 2024	events@launchcanada.org
Signed Waiver	12 July, 2024	Online form
Co**mpetition Fees**		
Competition Entry Fee ($250)	15 December 2023	e-transfer to adam@launchcanada.org Cheque or bank transfer possible.
Deadline for Refund of Entry Fee	24 May 2024	
Rocket Fee ($500)	7 June 2024	e-transfer to adam@launchcanada.org Cheque or bank transfer possible.
Rocketeer Fee ($65 per attendee)	7 June 2024	e-transfer to adam@launchcanada.org Cheque or bank transfer possible.

2.9.1 ENTRY FORM AND PARTICIPANT CLEARANCE

All teams are required to complete and submit an entry form to participate in this challenge. The entry form will allow teams to state their intent to participate, declare the category (or categories) in which they wish to compete and the expected number of students that will attend the competition event. Note that final confirmation of participation will occur after the technical report has been submitted and the proposed project has met the safety requirements (more details below). Teams may be denied the ability to participate should their project not meet the safety and engineering standards outlined in the *Launch Canada Design, Test and Evaluation Guide* document, and should those shortcomings not be rectified.

2.9.2 INITIAL DESIGN PROPOSAL & PRESENTATION

The first deliverables are intended to provide a technical overview of the team's project so that Launch Canada understands what the planned project is, and what the team's strategy is for completing it. This is an opportunity for the team to receive feedback from Launch Canada's volunteers, to ensure the team has a sound project and a feasible approach for achieving it, and to identify any potential problems early on.

Initial Design Proposal:

This shall be a written document that shall include:

- An overview of the team: its history and past accomplishments, structure, current members and leads.
- An overview of the team's past and planned outreach activities
- A summary of the planned project, highlighting the key design goals, performance targets, and design features.
- In the case of technology development projects, the report should present some background on the context behind the technology: why is it important? What industry need does it address? And it must identify what the final hardware deliverable will be and what sort of demonstration is proposed.
- An overview of the mission and concept of operations (CONOPS). In the case of a launch project, this should identify the major phases of flight and events, target apogee, and a preliminary trajectory simulation.
- A preliminary weight budget, showing a breakdown of vehicle weights as used in the preliminary trajectory simulation, and an overview of any assumptions made in producing this.
- A look at each subsystem, summarizing the key design features. For launch projects, this should include details of the planned airframe structure (materials, construction and key dimensions), fins (dimensions, thickness and attachment), recovery system (design parameters, parachutes, cords, attachments and deployment approach), avionics (description, identification of COTS and SRAD avionics, power sources, telemetry, and an overview of their planned installation and wiring) and propulsion (motor selection, mounting and thrust structure). For SRAD propulsion, it should also include the key details of the propulsion system, including the key performance parameters (propellants, thrust, chamber pressure, burn duration, estimated specific impulse), thrust chamber design (injector, chamber & nozzle sizing, seals, materials and construction details), propellant tank design (operating pressures and safety factors, sizing and key dimensions, materials, and an overview of construction / fabrication details), fluid controls (valves and actuators, regulators, instrumentation, overpressure protection), and any ground support equipment for propellant loading and engine operation.
- A summary of the planned payload, if any.

- An overview of planned component and subsystem tests, including when the tests will be performed and how the resulting data will be used.
- An overview of the project timeline.
- A summary of project risks, in other words, technical or non-technical factors that could affect the ability of the team to complete the project, and what is being done to mitigate those risks.
- Teams will also be expected to give a 30 minute virtual presentation (including audience questions) showcasing their team, its past and present projects and accomplishments, and provide an overview of their intended project for the Launch Canada competition and their strategy for executing it. The presentation will be evaluated on how well the team communicates the above to the audience and the quality of the presentation and audience engagement.

Note that it is reasonable at this stage for the team to still be considering multiple candidate designs (i.e., trade studies) for a given component or subsystem. In such cases, the candidate options should be summarized, and the team should identify how and when they will be choosing between them.

Initial Presentation:

Effective technical communication skills are critical in industry. It has been said that "a bad idea with a good presentation is doomed eventually, but a good idea with a bad presentation is doomed immediately". To encourage the teams to develop and demonstrate their presentation skills, following the submission of the preliminary design proposal, each team will present their project to Launch Canada's reviewers. The team should plan on a 30 minute presentation, followed by audience questions. The presentation should be accompanied by PowerPoint slides and any other audio/visual materials desired to showcase the team and project. Presentation slides need to be submitted a minimum of 48 hrs. in advance of the selected presentation time slot. This will allow the reviewers to read through the slides as well as the design proposal ahead of time.

All teams will be invited to pre-select their presentation time slot via an online sign-up sheet. It is crucial that key members involved in the design be available for the presentation since there may be questions regarding specific details and the design choices made by the teams.

In addition to providing the teams with technical and programmatic feedback, the reviewers will be scoring the team on their presentation. These scores will be based primarily on how effectively the team communicates their project, the overall quality of the presentation and how effectively the engage the audience and capture their interest.

The presentations and the following questions & answers will be recorded, and the video will be provided to the team for them to review. The reviewers will also provide the team with written feedback to help them as they progress with their projects, and will flag any particular concerns that the team will be expected to address.

2.9.3 PROJECT TECHNICAL REPORTS AND FORMS

The intent of the Project Technical Reports is to ensure that the rocket design and build process is properly documented. Additionally, they help evaluate the design and manufacturing decisions and allow corrections to be made earlier in the process. Feedback will be provided on all the submitted reports, and calls between the team and Launch Canada will be set up to discuss any areas of concern.

Templates for each of these reports may be found on Launch Canada's website.

Preliminary Design Report:

This report will be due early in the new year. It should refine and elaborate upon what was presented in the initial proposal, while demonstrating that any reviewer concerns from the initial proposal and presentation are being addressed. By this stage, the team's design should be largely complete, with all major subsystems and components designed and/or selected and few if any unresolved design choices to be made. As such, this report should represent a thorough description of the vehicle or project as it will be built.

The report should also include an up-to-date and fully fleshed out timeline, as well as an up-to-date testing plan and identification of project risks.

In addition, the report should include a thorough hazard analysis for the project. This should clearly identify any hazards associated with the project and operations, as well as potential hazards resulting from component or system failures. It should attempt to identify the likelihood and consequences of each, and identify how they will be mitigated, through design, operations, and/or safety measures. This section should clearly demonstrate to the reviewers that the team understands the hazards associated with their project, and has a sound approach for mitigating them.

Like the presentations, this report is an exercise in effective technical communications. For each subsystem, the team should be able to identify what the key information is that a reader would need in order to understand and assess the design. This should be presented as concisely as possible, making extensive use of clearly labeled and dimensioned figures. Supporting data and additional details, such as detailed drawings, calculations or detailed descriptions of analyses and/or tests may be included in appendices, with only the important highlights summarized in the main body of the report.

This report does not form part of the team's final score; rather, it is used by Launch Canada's reviewers to help ensure the team is on the right track to a project that will have a high likelihood of success, and most importantly, that will be deemed safe to launch.

Project Progress Report:

By this point in the project, manufacturing, procurement and testing should be well under way. The goal of this report is to present the progress that has been made on implementing and verifying the design. It should identify the work that has been done since the Preliminary Design Report, including the results of tests and analyses that have been performed. If unexpected problems came up during these activities, they should be identified and discussed, and any resulting changes to the design or project scope should be clearly identified. Any changes to the timeline or testing plan that may have occurred should be clearly identified. Reminder that tests must at minimum include those required by Launch Canada (see *Launch Canada Design, Test and Evaluation Guide*).

Like the Preliminary Design Report, the Project Progress Report is not part of the team's final score, but serves as a means for Launch Canada to ensure the team is progressing towards a safe and acceptable final product.

Engine Static Test Firing Request:

Static test firing of engines is a critical part of any SRAD rocket propulsion development and is also one of the most hazardous steps in the process of developing a rocket. Prior to performing any static test firing of engines, teams must submit their engine test stand design and static test firing procedure for review. Launch Canada will review test stand design and test firing procedure to ensure that they are acceptable and well thought out. This review is a straight-forward go/no go decision. Teams must receive approval before any test

firing attempts are made. Review of a team's test stand design and test firing procedure can occur whenever the team is ready, with the caveat that they should allow several weeks for the review. Additional information can be found the document *Requirements for Static Test Firing Approval*.

Any static tests to be performed at the Launch Canada event itself MUST have completed their static test firing approval. Additionally, any rockets to be flown at the competition that will be powered by a SRAD motor MUST have successfully completed full thrust, full duration static testing of the engine.

Final Project Report:

This report will be due approximately a month before the competition. It is the most important written deliverable and represents a significant component of the team's final score in the competition. It should be comprehensive, containing all details of rocket design, build and testing. This should include the research performed and appropriate tables and charts.

It should build upon what was presented in the Preliminary Design Report and Project Progress Report, and should reflect the final configuration of the rocket or project, thoroughly supported by analyses and test data. This report should convince judges of thoroughness, quality and reliability of the rocket or project in question. The more flight ready the team is at the "30 days to launch point", the more impressive this report will be. It would also be expected that teams include their assembly and pre-flight checklists in this document.

Design Deviation Form:

Although the Final Project Report should fully reflect the final product that will be brought to competition, Launch Canada recognizes that sometimes design changes might still occur for various reasons even after project deadlines and deliverables have been met. Though this is not ideal from a project management and systems engineering point of view, it is very important that any late modifications or changes to the rocket, project, or operations be thoroughly documented, substantiated and reported. Teams will be severely penalized if they bring a project to competition that unexpectedly differs from what was presented in the Final Project Report and those changes are not promptly made known to the judges and safety reviewers and clearly explained. Launch Canada will provide a standard Design Deviation Form to allow each team to concisely report any such "last-minute" changes in their rocket designs or technology demonstrator that they have applied after the Final Project Report was submitted, including any done during the competition itself.

If changes were made prior to arriving at the competition, the team will be expected to have a Design Deviation Form completed and shall present it at their safety inspection, to be signed by the safety reviewer.

Similarly, if any problems are identified during the safety reviews that require changes, the team shall identify all such changes and their rationale in an existing or new Design Deviation Form and will present this to the safety reviewers at the final prelaunch inspection, to be signed by the reviewer.

Once a team has successfully launched their rocket or completed their technology demonstration, the signed Design Deviation Form must be submitted to one of the head judges.

Recommended Supplemental Documents:

A major focus of Launch Canada is rigorous engineering design and development. As such, if a team has performed research, developed reliable testing or operating procedures and gathered well logged data, they may also submit that documentation to be reviewed. Creating a working system or procedure is valuable in industry and thus, effective procedures and well documented engineering drawings may also be submitted for some additional consideration.

For more information on the structure and content of these reports please refer to the Launch Canada report

templates. These templates are more guidelines to follow than a rigid structure, but they are intended to convey the basic content that is expected.

2.9.4 SITE PLAN (ADVANCED LAUNCH / TECH DEV)

Teams in the Advanced Launch or Technology Development category tend to have unique projects, with unique ground support equipment, propellants / energetics, and quantities. And these can all differ greatly from project to project. To enable safe and efficient site setup, all teams in the Advanced Launch and Technology Development categories must submit a site plan to Launch Canada. This is due at the same time as the Progress Update.

The Site Plan must include:

- A clear, labeled and dimensioned schematic of the launch or test area, showing at minimum:
    - The launch pad or test stand
    - Any blast deflection devices, clearly indicating the direction they will be oriented, or the permissible range of directions.
    - Location of any anchor points for guy wires, cables, and any other launch pad or test stand anchoring features, including a description of the type of anchor
    - Location of all major pieces of ground support equipment
    - Location of all propellant vessels, compressed gases and pyrotechnics. This must include their location during the test itself, as well as the location of any storage or marshalling areas where they may be kept.
    - Location of all safety gear
    - Location and description of any required terrain features:
        - Berms or embankments
        - Ditches
        - Trenches
        - Walls
        - Etc.
    - Location of any required vehicle access routes. Remember that the site will likely be sandy, with natural impediments to vehicles. If it is critical for you to be able to get a vehicle in to certain areas, those areas should be clearly indicated.
    - Dimensioned safety clear zones around the launch pad, test stand, and any other areas that may require it (e.g. propellant storage areas). All calculations of clear zones must account for both overpressure and shrapnel.
    - Dimensioned zones that must be kept clear of shrubs, trees and any other flammable objects
    - Indication of where personnel need to be during a launch or test, including:
        - Minimum required distance
        - Maximum allowable distance
        - Any directionality constraints: can personnel be located anywhere outside a certain radius, or do they need to be in a specific direction from the site? How much flexibility is there on where personnel are stationed?
        - Any sight line constraints
        - Any required structures or gear at the personnel area: tents, canopies, tables, bunkers, etc.
    - Note: all dimensions should be provided relative to the launch pad / test stand

- An itemized list of all energetics that will be present, including both the number and the mass or volume, referenced to the site schematic:
    - Compressed gas cylinders
    - Fuels
    - Oxidizers
    - Pyrotechnics
    - Generators
- An itemized list of any anchoring features that are needed, including the type, number and size. This can include concrete blocks, sandbags, ground anchors, etc.
- An itemized list of any safety gear, beyond normal PPE, that the team will be bringing or requiring. This could include fire extinguishers, water tanks / pumps, fire blankets, shovels, first aid kits, etc.

2.9.5 VIRTUAL INSPECTIONS

A major goal of preflight rocket safety inspections is to verify the overall build quality of the rocket. This cannot easily be assessed by a design report, but discovering major problems during safety inspections at the event itself leaves very little time to address them. As a result, teams must schedule a virtual rocket inspection at least 2 weeks prior to the launch event. This can be done over Zoom or a similar video-capable platform. The team will be expected to show their completed rocket to Launch Canada's safety inspectors, and should be prepared to disassemble and interact with components at the request of the inspectors, provide closeup views of features of the rocket or project, and answer any questions the inspectors may have. The goal is to catch significant problems in enough time for the team to address them prior to the competition, reducing the amount of emergency rework teams need to perform at the event, and streamlining the in-person inspections.

2.9.6 OPS REHEARSAL (ADVANCED LAUNCH)

Teams in the Advanced Launch category, particularly those flying hybrid or liquid propellant vehicles, typically require significant ground support equipment that adds a large amount of operational complexity compared to COTS solid rockets. Designing a safe and efficient operation is frequently as complex as designing the rocket itself, if not more. Experience has shown that a majority of hybrid or liquid teams fail due to problems with their ground support equipment, and due to excessively time-consuming setup and tear-down that leaves the team with little margin to address problems when they do arise.

Moreover, your team will be working in relatively close proximity to other teams. Your operations affect them, and their operations affect you. If the launch area has to be closed for an excessive period of time because a team's hazardous operations, propellant fill, and/or abort are overly slow, this impacts all the other teams.

As a result, Launch Canada requires all Advanced Launch teams to complete an Ops Rehearsal prior to the competition. This will be a "wet dress rehearsal" of the actual launch, and it must include:

- The complete setup of the launch rail and ground support equipment
- Installation of the rocket onto the launch rail
- Anchoring the rocket to prevent it from accidentally departing the rail
- Performing a complete propellant fill, preferably using simulated propellant if appropriate
- After fully filling the rocket, executing an abort procedure to return the rocket to a safe state

- Lowering the rail, removing the rocket, and tearing down the launch rail and ground support equipment

The team must submit proof of this rehearsal in the form of a video (timelapse is acceptable) and a short accompanying summary report. The report must include:

- A summary of the test
- A timeline showing:
    - All major events in the setup and teardown
    - The start and completion of propellant loading
    - The start and completion of the abort procedure
- A summary of any problems or unexpected issues encountered during the test
- A summary of any lessons learned

Among other things, Launch Canada will be looking to verify that the fill and abort times do not exceed 30 minutes.

Teams must notify Launch Canada at least 2 weeks in advance of this rehearsal, and Launch Canada will additionally aim to have a representative attend to witness the test.

2.9.7 ADMINISTRATIVE DOCUMENTS

2.9.7.1 SCHOOL PARTICIPATION LETTER

To ensure that each student team is participating with consent and support from their university, a participation letter is required. This will also be required to verify that a team is allowed onto the launch site premises. The important information required on this document is the name, date and purpose of this event. It should show confirmation of attendance and the names of the participants who will be on the launch site.

2.9.7.2 SCHOOL PROOF OF INSURANCE

Launch Canada's insurance policy provides liability coverage for Launch Canada and its staff. To ensure that students and their schools are covered in the case of accidents or damages that may be caused due to their actions and rocket, each team must provide proof of insurance coverage from their school. This should include comprehensive general liability coverage in the amount of at least $2 million, covering injury or property damage.

2.9.7.3 WAIVER AND RELEASE OF LIABILITY FORM

A signed waiver from every person attending the event is required. Entry to the launch site will be denied without a filled form. This form can be found on the Launch Canada website.

2.9.8 COMPETITION FEES

Launch Canada works hard to support and create opportunities for Canada's student rocketry community and does everything in its power to minimize the costs that have to be passed on to the student teams, but unfortunately some fees remain necessary to help cover the expenses associated with putting on an event such

as this. There are three components that make up the competition fees. These are as follows:

- **Competition Entry Fee: $250 per team**
  This fee is due as part of competition registration and helps cover rental, equipment and other costs ahead of the event. It is refundable if a team withdraws prior to May 19, 2023. After this point, it becomes non-refundable.
- **Rocket Fee: $500 per team**
  The rocket fee helps cover fixed costs of the event (i.e., those that are not directly related to the number of students in attendance).
- **Rocketeer Fee: $65 per student**
  The rocketeer fee helps cover the costs that are a function of the number of students in attendance.

2.10 AWARDS AND SCORING

2.10.1 CATEGORY "PLACE" AWARDS

Teams will be competing for 1st, 2nd, and 3rd places in each of the challenge categories. This placement will be evaluated based on a combination of all the project deliverables, including presentations and launches / demonstrations.

Both the Advanced Launch Challenge and the Technology Development Challenge will feature prize money for the top three teams:

1st place: $3000

2nd place: $1500

3rd place: $500

The Basic Launch Challenge will feature motor hardware donated by Cesaroni Technology as prizes.

On the days during the competition itself, all projects will be evaluated by a team of judges, and feedback will be provided to each team.

Each of the deliverables will have its scoring rubric and this will be disclosed to teams prior to submission. These scoring documents and evaluation checklist can be found in the *Launch Canada Judges Handbook*.

2.10.2 ADDITIONAL AWARDS

In addition to the category awards, targeted awards may be offered by partner organizations to incentivize particular technologies or missions. These will be announced on an ongoing basis and/or included in the *Launch Canada Judges Handbook*.

2.11 DISQUALIFICATION FROM CONSIDERATION FOR ANY AWARD

In extreme cases where teams deviate from rules regarding safety standards while handling rockets and safe range operations they will be disqualified from the competition. Teams that disregard the *Launch Canada Design, Test and Evaluation Guide* document and develop an unsafe or unregulated technology will also not be considered for any awards. In special circumstances where teams display extremely disrespectful behavior and disregard the wellbeing of others, they may be disqualified from the competition. Judges and event staff reserve the right to log, report and evaluate these circumstances. Further details on all judging and scoring requirements for the Launch Canada Challenge, and circumstances that may disqualify a team will be made

available in the *Launch Canada Judges Handbook*.

2.12 WITHDRAWAL FROM COMPETITION

Teams may encounter issues that prevent them from attending the competition. In such situations, the event organizers must be informed of a decision to withdraw from the competition. This shall be done via a formal email to competition@launchcanada.org, and cc'd to adam@launchcanada.org.

- If the team withdraws on or before the Deadline for Refund of Entry Fee (see Section 2.9), the entry fee will be refunded. After this date, the entry fee becomes non-refundable.
- If the team withdraws after the payment of the Rocket Fee and Rocketeer Fee for the event, those fees may not be refunded but may be carried over to the following year, at Launch Canada's discretion.

APPENDIX A: ACRONYMS, ABBREVIATIONS, AND TERMS

ACRONYMS & ABBREVIATIONS	
AGL	Above Ground Level
APCP	Ammonium Perchlorate Composite Propellant
CAR/ACF	Canadian Association of Rocketry / Association Canadienne de Fuséonautique
CFR	Code of Federal Regulations
COTS	Commercial Off-the-Shelf
DTEG	Launch Canada Design, Test and Evaluation Guide
FAA	Federal Aviation Administration
IREC	Intercollegiate Rocket Engineering Competition
LC	Launch Canada
LOX	Liquid Oxygen
SRAD	Student Researched & Developed
STEM	Science, Technology, Engineering and Mathematics
TC	Transport Canada

TERMS	
Amateur Rocket	14 CFR, Part 1, 1.1 defines an amateur rocket as an unmanned rocket that is "propelled by a motor, or motors having a combined total impulse of 889,600 Newton-seconds (200,000 pound-seconds) or less, and cannot reach an altitude greater than 150 kilometers (93.2 statute miles) above the earth's surface".
Excessive Damage	Excessive damage is defined as any damage to the point that, if the systems intended consumables were replenished, it could not be launched again safely. Intended Consumables refers to those items which are - within reason - expected to be serviced/replaced following a nominal mission (e.g. propellants, pressurizing gasses, energetic devices), and may be extended to include replacement of damaged fins specifically designed for easy, rapid replacement.
FAA Class 2 Amateur Rocket	14 CFR, Part 101, Subpart C, 101.22 defines a Class 2 Amateur Rocket (aka High Power Rocket) as "an amateur rocket other than a model rocket that is propelled by a motor or motors having a combined total impulse of 40,960 Newton-seconds (9,208 pound-seconds) or less."
Non-toxic Propellants	Launch Canada considers ammonium perchlorate composite propellant (APCP), potassium nitrate and sugar (aka "rocket candy"), nitrous oxide, liquid oxygen (LOX), hydrogen peroxide, kerosene, propane and similar, as non-toxic propellants. Toxic propellants are defined as requiring breathing apparatus, special storage and transport infrastructure, extensive personal protective equipment, etc.