PREFACE

Dear Students,

Welcome to the Canadian Stratospheric Balloon Experiment (CAN-SBX) Design Challenge! CAN-SBX is Canada's only national competition for post-secondary students to design and build a small payload to be flown onboard a stratospheric balloon provided by the Canadian Space Agency. The CAN-SBX challenge was conceived to be a real-world opportunity for students to conduct meaningful stratospheric research. As such, it will push your limits as you learn skills not taught in traditional classrooms. Resourcefulness and perseverance are among the many things you will develop throughout this experience, which are always in high demand in the space sector. We hope you will be inspired to apply what you've learned to even greater challenges being faced today to responsibly advance humankind's presence in space.

In this handbook, you will find information about the rules and regulations of the competition, deadlines for submissions, and guidelines on how to complete major project milestones. Although this document is intended to be comprehensive, we encourage you to contact the organizers, listed under 'Important Contacts', for further details. We look forward to seeing you at the CAN-SBX campaign!

— The entire SEDS-Canada team

SEDS-Canada (Students for the Exploration and Development of Space) is a student-run non-profit, federally incorporated since October 2014. We are a member-based organization with hundreds of members all across Canada who partners with many established university student groups.

We are dedicated to promoting the development of the Canadian space sector and supporting our fellow students who wish to pursue careers in this industry. To achieve this mandate, we offer students opportunities for professional development. Our strategy includes national competitions such as CAN-RGX and CAN-SBX, an annual conference, and other events.

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KEY CONTACTS

To submit project milestones (Proposal, PDR, CDR, ESDP), and for any comments, questions, or concerns, please email cansbx@seds.ca

Andrew Karim | CAN-SBX Project Manager

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Andrew is a first year master's student in physics at Université Laval and a physics engineering graduate. Since his participation in the 2020-2021 CAN-SBX competition with the PolyOrbite team from Polytechnique Montréal, he has been heavily involved in different space engineering projects. He is now looking forward to offering a similar chance to other students to launch their career in space by guiding them through hands-on, engaging and fun projects!

Makenna Kuzyk | CAN-SBX Assistant Project Manager

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Makenna is currently in her 4th year of a mechanical engineering co-op degree at the University of Alberta. She was part of the 2023 Zenith Fellowship Class and part of AlbertaSAT. Along with the amazing opportunity to assist the CAN-SBX challenge, Makenna also founded and co-leads a CAN-RGX microgravity robotics project team called Mission SpaceWalker. She now is an intern at the CSA on projects including the STRATOS campaign. With a passion for space, Makenna hopes to one day be exploring past the stars she studies.

Ashley Ferreira | CAN-SBX Assistant Project Manager

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Ashley is in her last year of the Physics & Astronomy co-op program at the University of Waterloo. She's done co-op terms working in particle physics, defence intelligence, international relations, remote community renewable energy research, space robotics, and astronomy. In her spare time, she loves going on roadtrips, camping, and sailing.

Connor McNeill | SEDS-Canada Projects Chair

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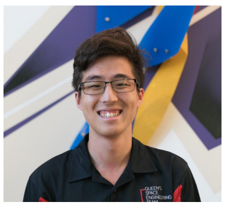
Connor is the newly appointed Projects Chair at SEDS-Canada. He is currently in his second year of mechanical engineering at the University of Alberta with a huge interest in space. His ultimate goal in life is to bounce around on the moon!



James Xie | CAN-SBX Project Advisor

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James has a bachelor's degree in Engineering Chemistry from Queen's University and is currently studying a Master's in Space Studies at the International Space University. He has worked as an operations consultant for the past three years, delivering multiple improvements to manufacturing processes and capital projects across various industries. James' interests are in space systems engineering and earth observation applications.

Project Advisors/Subject Matter Experts

- **Philippe Vincent**, STRATOS Mission Manager, Canadian Space Agency
- **Martin LaFlamme**, STRATOS Expandable Balloon Lead, Canadian Space Agency
- **Annie Rosenzveig**, Payload Manager, Electrical Engineer, Canadian Space Agency
- **Matthew Chila**, Payload Support, Mechanical Engineer, Canadian Space Agency
- **Vlad Popovici**, Electrical Engineer, Canadian Space Agency
- **Benoit Gangon,** Systems Engineer, Canadian Space Agency
- **Cindy Dorneval,** Safety Engineer, Canadian Space Agency

ABBREVIATIONS

CDR — Critical Design Review

CSA — Canadian Space Agency

EDT — Eastern Daylight Time

EST — Eastern Standard Time

ESDP — Experiment Safety Data Package

OAR — Outreach Activities Report

PDR — Preliminary Design Review

SEDS — Students for the Exploration and Development of Space

SME — Subject Matter Expert

STEM — Science, Technology, Engineering and Math

TBA — To Be Announced

TBC — To Be Confirmed

WBS — Work Breakdown Structure

1. COMPETITION OVERVIEW

1.1. Project Scope

The Canadian Stratospheric Balloon Experiment Design Challenge (CAN-SBX) is a competition for Canadian post-secondary students to design, build, and test a small scientific experiment onboard a high-altitude balloon at up to 30 km in altitude. The student payloads will also be supporting CSA efforts to demonstrate Canadian high-altitude balloon launch capabilities with small payloads.

Post-secondary students from Canadian universities are challenged to submit a proposal of their payload design in accordance with constraints set by the Canadian Space Agency (CSA) and SEDS-Canada. Any student team from a post-secondary academic institution can submit a proposal for their experiment, and the top teams will have the opportunity to build and launch their experiment in **Timmins, Ontario, around June 2024**. Students will be responsible for overseeing the execution of their experiment.

CAN-SBX is a unique opportunity for students to access a platform for ground-breaking research in the stratosphere and complete a full engineering design cycle from conception to execution to gain transferable professional skills such as project management and risk mitigation for careers in the Canadian space industry. Student teams will also have the opportunity to work with Subject Matter Experts who will coach and mentor them throughout the competition and gain experience through operating a mission with the CSA.

The goal of this year's CAN-SBX project is to train students to be able to launch their own high-altitude balloons in the future. Students may have the opportunity to participate in the launch and recovery efforts during this year's flight campaign.

The CAN-SBX Student Handbook is a resource detailing the full requirements and expectations of participating students, teams, faculty, and partners. The Handbook will guide teams through every step of the development cycle, but if any questions arise that are not answered here they should be addressed as soon as possible to cansbx@seds.ca.

1.2. Eligibility & Team Guidelines

Any undergraduate student enrolled at recognized post-secondary institutions in Canada is eligible to enter this competition. **Students are required to provide proof of enrollment at the time of submission of the proposal.** Graduate students (i.e. enrolled in Masters, PhD, and Postdoc programs) cannot form a team but may join undergraduate teams. The percentage of graduate students and high school students per team must not exceed 34%. At least one member of your team must be/become a member of SEDS-Canada (see seds.ca/membership/). Teams must obtain a Faculty Advisor and must submit a Faculty Letter of Endorsement at the Proposal stage (see Section 11.10).

Teams must be composed of at least 4 students, including at least 2 engineering students. Teams may have additional faculty advisors (from the primary or any collaborating institutions) as needed.

Table 1-1: Relevant definitions for teams

Primary Institution	A recognized college or university in Canada where the team leader is enrolled as a student.
Collaborating Institutions	Colleges, universities, and high schools that have contributed time and/or resources to the project.
Team Leader	The team leader is responsible for organizing and coordinating the efforts of the entire team for the duration of the project. The team leader must be enrolled at the team's primary institution.
Faculty Advisor(s)	The faculty advisor(s) is required to attend progress meetings via teleconference. Faculty advisors cannot become SMEs or project reviewers/judges for the competition.

1.3. Competition Timeline

1.3.1. Project Milestones

This timeline is subject to change during the course of the competition. Updates will be communicated to teams and reflected on the project site. Please refer to seds.ca/can-sbx for the most up-to-date timeline.

Some milestones include documents that must be submitted by selected teams for evaluation. Instructions for creating these documents can be found in their respective sections of this handbook. Presentation slides must be sent on the Sunday before the presentation week. All submissions must be emailed to cansbx@seds.ca.

- Week of **Oct 30, 2023**: KickOff meeting with SMEs and selected teams
- Sun., **Dec 3, 2023**: Submit Technical Questionnaire (QT)
- Week of **Dec 4, 2023**: Progress Presentation 1 and Outreach Activity Report 1
- Week of **Jan 29, 2024**: Present **PDR** via teleconference to SMEs
- Week of **Feb 5, 2024**: Submit version 1 of **Experiment Safety Data Package (ESDP)**
- Week of **Feb 26, 2024:** Progress Presentation 2 and Outreach Activity Report 1
- Week of **Mar 18, 2024**: Present **CDR** via teleconference to SMEs
- Week of **Mar 25, 2024:** Submit version 2 of **Experiment Safety Data Package (ESDP)** and updated Feedback Sheet
- Week of **Apr 15, 2024:** Progress Presentation 3 (if necessary)
- Sun., **May 5, 2024, 11:59 PM (ET)**: Submit **final ESDP** and updated Feedback Sheet
- **June, 2024**: Launch Campaign period (TENTATIVE)
- Fri., **Aug 16, 2024**: Submit your Post-Flight Survey and Outreach Activity Report 3
- Week of **Oct 21, 2024:** Virtual presentation about the experiment/outcomes of the experiments to SEDS-Canada and CSA

1.4. Format Guideline for Document Submissions

The following guidelines should be followed for all report submissions, including the proposal.

- PDF file type
- Submitted electronically to cansbx@seds.ca
- Use the following file name format: *teamname_filename_year.pdf (ie: UVic_PDR_2021.pdf)*
- Standard 8 ½” x 11” pages
- 1” margins on the top, bottom, and sides

- 12-point Times New Roman font
- Numbered pages on the bottom right corner

1.4.1. Submissions in French

Please submit all written work in English. Note that a French version of this handbook does not currently exist. If there is any confusion about a section, please reach out and we can provide a translation.

Presentations may be performed in French, however, we do ask that slides be written in English or an English translation of the slide be provided in the appendix. If there is critical information presented in the slide that is not written (i.e. it is only spoken), please include an English translation of the information as a note on the slide.

Please reach out to cansbx@seds.ca with any feedback or questions about our French language policy!

1.5. Funding Expectations

Funding for the CAN-SBX project is not provided. Student teams should not expect funding from SEDS-Canada or the CSA and should exhaust all existing routes to fund their experiments (e.g. Student Union grants, University-based travel grants, partnerships with industry specific to their project, crowd-funding campaigns, etc.).

Please contact cansbx@seds.ca with any funding concerns (especially if it is prohibitive to your team submitting an application).

1.6. Flight Overview & Basic Requirements

For reviewers to assess the project proposal, hardware **must** meet the following constraints below:

- Maximum 5 kg weight limit
- The payload must be contained in a cylindrical volume of up to 524 mm in height and 285 mm in diameter, shown in Figure 1.
    - **Note:** It is possible for the payload to have a Nadir view through the bottom of the gondola as long as the payload respects the available volume.
    - **Note:** You may propose a payload that has small components which protrude from the allowed volume (e.g. antennas). However, you must acknowledge in your proposal that you would need to complete a Request for Deviation for this requirement and be aware that **a request may not be approved.**

- Self-powered - the balloon gondola will not provide power to the payload.

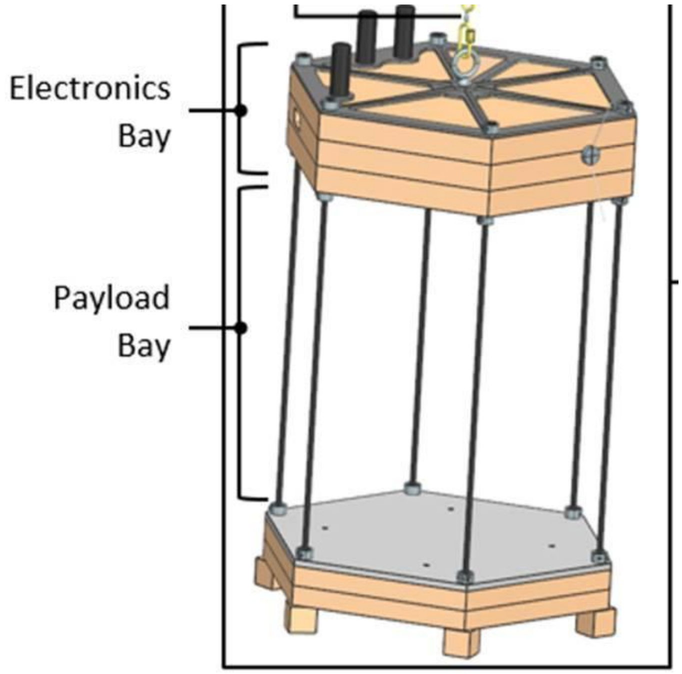


Figure 1: Payload volume must fit within the payload bay and not conflict with the 6 structural rods.

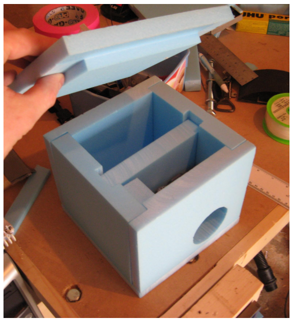
The experimental design **must** also be able to function under the following flight constraints:

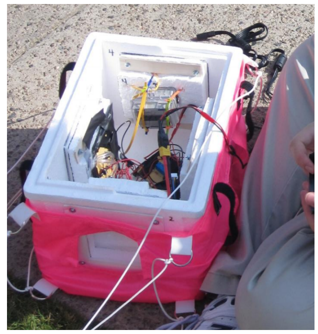
- Non-pointing: balloon orientation is not controlled
- Non-insulated: balloon temperature is not controlled and can reach temperatures of -56 degrees Celsius
- Flight will occur during the mornings or potentially late afternoons
- ~3-hour flight
- Up to 30 km altitude
- Flight profile: balloon will reach ceiling height and burst
- Communication/telemetry is not facilitated by the CSA. Teams are responsible for their own communication system or retrieving data from the payload after landing.

Flight launch, tracking, and recovery will be provided by the CSA. There may be opportunities for students to directly participate in all three stages of the flight by shadowing the CSA team. Please review the CSA STRATOS Expandable Balloon Payload Requirements and User's Manual for additional details and requirements needed in your design.

1.6.1. Experiment Enclosure

Enclosures for small-scale high-altitude balloon missions are typically made of high-density Styrofoam or Formular Polystyrene, which is easy to manipulate, lightweight, inexpensive, and buoyant. Figure 2 (below) shows example enclosures.





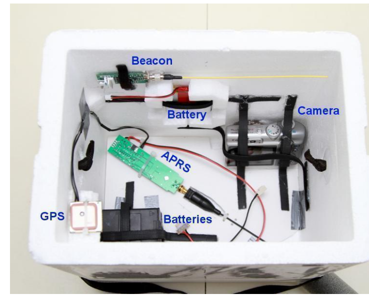


Figure 2: Examples of Styrofoam enclosures for high altitude balloon flights.

1.6.2. Publicity Guidelines

SEDS-Canada is committed to organizing and supporting this amazing learning opportunity for future participants. All participants selected to take part in the project will be asked:

- for consent in being featured in photo/video content for the purposes of SEDS-Canada publicity material (can opt-out),
- for consent to use submitted materials in advertisement campaigns (can opt-out), and
- **to acknowledge the work of SEDS-Canada in the organization of this campaign or include SEDS-Canada as a contributor in any external publicity, social media materials, outreach activities, or the like.**

This will help us advertise our organization and the CAN-SBX program to future participants and potential sponsors, allowing us to continue hosting these amazing experiences.

2. KICK-OFF & COMMUNICATION

2.1. Scheduling Meetings

There will be regular meetings throughout the course of the CAN-SBX competition.

A SEDS-Canada CAN-SBX representative will typically reach out to student teams a week or two in advance with availabilities based on CSA and SEDS-Canada schedules. Teams are expected to pick a time slot within the available dates/times provided. Once a date/time is selected, a meeting invite will be sent with instructions on how to join the meeting.

Meetings are typically conducted using Microsoft Teams or Google Meets.

2.2. Kick-off Meeting Overview

The Kick-Off meeting takes place with selected teams, SEDS-Canada personnel, and the CSA SMEs. CSA SMEs will provide an overview of the STRATOS Expandable Balloon Payload Requirements and User's Manual and answer initial questions from the team(s). This is an excellent opportunity to introduce yourselves and meet the experts who will be helping you along the way!

Prior to the meeting, it is recommended to review the STRATOS manual and prepare questions or concerns. It is also useful to understand your team's capability to meet the requirements, and the resources you have available to be able to highlight areas where additional support may be required.

3. PROGRESS PRESENTATIONS

3.1. Overview

Progress presentations are a chance to check-in with teams before major milestones and provide an opportunity for feedback, asking questions, raising concerns, and practicing presentation skills. The focus of progress presentations is on project management to make sure your team is set up for success, whereas the design reviews will focus more on technical elements.

Teams are expected to be professional in their presentations. This is a great chance to receive help; we are all here to help you towards a successful design!

Slides should be submitted to cansbx@seds.ca as a PDF on Sunday before the week of the presentation (see timeline is Section 1.3.2). Presentations will be kept to a strict 20 minutes, with 40 minutes at the end for questions (from you and us).

3.2. Presentation Content

The presentation should summarize the following content, however if a topic is not relevant to the progress meeting for your team, it should be explicitly stated with a rationale.

1) **Title slide** — Include all team information, and responsibilities of each member.
2) **Brief Project Update** — Outline work that has been completed since the last milestone, such as:
    - Your payload mission success criteria table & scoping of your project
    - Design changes and/or testing updates based on feedback from previous milestones (if applicable)
    - Are there areas in your project that you are struggling to design/analyse/test? Are you concerned with access to any resources?
3) **Risk Analysis** — Present your risk matrix (please include risk tables in the appendix) including technical, managerial, and health risks. Have any risks moved (i.e. from mitigations implemented, from the risk materializing, or changing conditions such as being later in the design process)? Are there new risks or have risks been eliminated?
    - It may be helpful to colour code your risks based on the primary project metric they would affect (e.g. is it a financial risk, timeline risk, health/safety, etc.)
4) **Timeline** — Present a full project timeline and highlight immediate next steps to reach the next milestone. Are you ahead of schedule, on schedule, or behind schedule?
    - Please divide your timeline by scope (i.e. power, on-board computer, structure, etc.) to show the next steps for each scope
    - Be sure to take into consideration busy periods in school, lead times for procurement, and contingency periods based on the risks identified
5) **Budget** — Update on whether your team is currently on budget, over budget, or under budget, and any major changes in funding. Please provide an updated budget table (may be in the appendix).
    - *This is especially important for PP2 as the launch campaign approaches to have a well-defined detailed budget.*
6) **Personnel** — Provide an updated work breakdown structure, highlighting changes to personnel on the team and any concerns with the team's ability to staff each scope.
7) **Outreach** — Update on outreach activities completed by the team. ***Please additionally submit an Outreach Activity Report using the template in Section 8.***
8) **Any other topics the team wishes to address including questions, concerns, and roadblocks.**

4. PRELIMINARY DESIGN REVIEW (PDR)

4.1. Overview

After your proposal has been reviewed by the judging panel, you will be notified if you have been approved to continue with the design process. Your team will be required to give a PDR presentation and submit an ***Experiment Safety Data Package (ESDP)*** required by the CSA containing a technical review of your payload. Deadlines are listed in Section 1.6.

Alongside Section 1.6, **further requirements** and flight data are listed in the CSA's STRATOS Expandable Balloon Payload Requirements and User's Manual (CSA-STRATOS-MAN-0011). *Teams are responsible for reading the STRATOS documentation to understand the complete set of requirements. Questions should be directed to cansbx@seds.ca as soon as possible.*

The PDR must provide evidence that your experiment will satisfy all design requirements based on preliminary quantitative analyses and hardware specifications. During the presentation, SMEs will provide comments, feedback, and any concerns they may have about your experiment. You will have 7 days to make revisions to your ESDP before submission which must address any issues raised from the feedback received and present updated design specifications. We encourage you to complete both the ESDP and the presentation by the presentation deadline, and then make minor changes to the report after the presentation.

An unsuccessful or incomplete PDR can lead to project cancellation at the discretion of SMEs.

4.2. Presentation

Teams will be required to provide a **40-minute** presentation followed by a 50-minute discussion period to our panel of SMEs and judges via teleconference. The presentation file format is up to you (PDF, PPT, KEY, etc.). **Teams must submit their PDR slides to cansbx@seds.ca in advance of their scheduled CDR presentation** (see Section 1.3.2 for the Timeline). You must convince the SMEs that your experiment is compliant with payload requirements. **Be prepared to answer technical questions**. Please structure your presentation as follows:

1) **Title slide** — Include all team information, and responsibilities of each member.
2) **Introduction** — 1-2 slides on the topic of research and the proposed experiment
    - This should include a mission objectives & success criteria table (see Section 11.1)

3) **Requirement compliance and safety (see [Section 11.4](#))**

- Present a compliance chart (RVCM). Summarize the results from any prototyping and testing done to date used to validate compliance.
- Provide a plan to achieve compliance for any requirements not yet fully compliant, including test/analysis methodology, referring to the CSA relevant requirement.
- Highlight any areas where you ***do not plan to be compliant***, including rationale for the deviation and the proposed next steps to show the deviation will not pose a safety risk. *You may need to go into more detail in the following sections.*

4) **Experiment design**

- Include full system specifications and diagrams. Organize your slides to follow the ESDP headings:
    i. Mechanical design
        1. Label the center of mass & include a mass budget.
        2. Detail the mounting interface.
        3. Load cases applied and a summary of the results.
        4. Thermal protection
    ii. Electrical design (diagram should include details such as the type of batteries, voltage regulators, and any other control elements)
        1. Label/show the overall power available and usage.
        2. Electrical protection implemented.
        3. Wire gauges and harnessing method
        4. Grounding scheme
        5. RF transmitters and receivers (incl. all frequencies used)
    iii. Software design
        1. Outline the functionality/architecture of your software

5) **Safety**

- Summarize all hazards and the mitigation strategies/barriers adopted for each.
- Summarize the results of or plans for safety critical testing to demonstrate your payload's safety.
- Describe your handling, testing and calibration, and recovery procedures, with an emphasis on how to keep crews safe while handling your payload.

i. A concept of operations diagram may be helpful here.

4.3. Documentation

The ESDP will be used for final design approval by the CSA prior to launch, however a preliminary ESDP will be required at PDR. The template for the ESDP is given in the STRATOS Expandable Balloon Payload Requirements and User's Manual **with additions required by SEDS-Canada**. At this milestone, some sections of the ESDP may contain preliminary information, however the overall design should be representative of the payload's flight configuration. The ESDP should be formatted following the guidelines listed in Section 1.4.

Please make sure to include all sections outlined in section "5.2.1. ESDP Required Content" in the CSA-STRATOS-PR-0004 document. These sections are required by the CSA.

Note: in addition to the ESDP required information, your cover page should include the names of your team members, date of submission and logo (optional).

Following the sections required by CSA, please include the following additional sections that are required by SEDS-Canada:

Experiment Testing

- Describe any prototypes built to test the experiment, lessons learned, and non-safety critical testing done to verify the functionality of your payload (including software verification outside of safety-related tests described earlier).
    - *Discuss the next steps in your payload development based on your test results. This may be referred to in Section 6.2.*
    - Each team should complete one full cycle of ground test experiments, as you would in the flight, prior to the CDR. Provide a plan for these tests at the PDR stage, including the methodology and the variables to be measured.
    - Describe how the test environment differs from the flight environment and how that impacts the veracity of your test results.
- Update your technical risk assessment tables[1] with new estimates of probability and consequence as a result of your mitigations or design changes, and changes to your future mitigation and contingency plans. Use the templates provided in Section 11.2 to list the risks.

Flight Procedures (*This section may be high-level or largely TBD at the PDR stage)*

- Outline the procedures (as applicable) to be performed during pre-flight setup, in-flight, and post-flight using templates provided in Section 11.9. Identify specific team member responsibilities.

[1] Note that only experiment-critical technical risks (ones that would mean the failure of your experiment) are required to be outlined in a table here. Hazard assessment (human safety risk) is included in the Hazard sheets. Managerial risks (e.g. funding, resourcing, etc.) will be reviewed during Progress Presentations.

- Briefly describe the data output you expect from the flight and the steps to be taken to analyze the data and interpret the results.

Project Management

- Update your timeline forecasts and actual dates, including details for upcoming activities needed to reach the CDR. Please refer to the relevant RVCM or payload functional requirements to determine activities needed. Comment on changes between your original plan and your updated forecasts/actuals, such as what has been effective for your team and any contingency plans underway.
- Update your budget forecasts and actual spendings. Comment on changes between your proposal plan and your updated forecasts/actuals, such as what has been effective for your team and any contingency plans underway.

4.4. Feedback

You will be given feedback on many occasions throughout CAN-SBX. Please remember that this is an opportunity for you to constructively assess your project and then improve it!

While verbal feedback is expected after every presentation, the CSA will also provide a Feedback Sheet to track outstanding items. The Feedback Sheet is typically an Excel file provided by SMEs after your ESDP submissions. An example row is provided below.

In this scenario, an SME noticed a secondary OBC was missing from the mass budget and recommended that the team add the missing information. The team responded to this question/comment and upon agreement with the SME, this item's status would be changed from Open to Closed on the Feedback Sheet at the next major review.

No.	Reviewer	ESDP Section	Page	Description of Comment or Question	Recommended Action	Team Answer	STATUS	Comments
1	SME Name	1.2.5 Mass Budget	16	Secondary OBC missing from C&DH section of mass budget	Add secondary OBC to the mass budget	SOBC mass was added to the mass budget and the table updated	Open	Additional comments provided here

5. CRITICAL DESIGN REVIEW

5.1. Overview

The Critical Design Review (CDR) must demonstrate that your experiment design has achieved a sufficient level of maturity to proceed with full-scale manufacturing, integration, and testing on an expandable balloon.

The CDR will be presented to SMEs for feedback via a presentation, and then an updated ESDP document will be submitted 10 days later. Comments from judges during the CDR presentation must be addressed in this document. It is recommended to complete both the report and the presentation by the deadline, and then only make minor changes to the report after the presentation. The CDR deadlines are given in Section 1.3.2.

An unsuccessful or incomplete CDR can lead to project cancellation at the discretion of SMEs.

5.2. Presentation

Teams will be required to provide a **40-minute** presentation followed by a 50-minute discussion period to our panel of SMEs and judges via teleconference. **Teams must submit their CDR slides to cansbx@seds.ca in advance of their scheduled CDR presentation** (see Section 1.3.2 for the Timeline). You must demonstrate that your design satisfies all requirements with detailed, compelling evidence. You must be prepared to answer technical questions. Please structure the presentation as follows:

1) **Title slide** — Include all team information and responsibilities of each member.
2) **Introduction** — 1-2 slides on research topic and experiment
    - Include your final Mission Objectives & Success Criteria table
3) **Present a requirement compliance table**
    - All requirements are expected to be compliant or partially compliant (with a clear path to compliance) at the CDR stage, unless a request for deviation has been submitted.
    - Describe any testing conducted and the results that validate your compliance.
4) **Technical Experiment and Procedures**
    - Final system specifications and diagrams, following the ESDP headings (see Section 5.2; PDR Presentation)

- Using the flowchart templates provided in Section 11.9, describe procedures for both pre-launch (to get the payload ready for flight), in-flight (if applicable), and post-flight recovery operations, along with team responsibilities.

5) **Safety Information**

- Provide updates on safety systems, following the ESDP headings (see Section 5.2; PDR Presentation)

Highlight the most important milestones completed to date and the remaining tasks to accomplish prior to the integration of your experiment with the Gondola.

5.3. Documentation

The ESDP document submitted post-CDR should be an updated version of the ESDP submitted post-PDR, following the same outline as Section 5.3. At this point, requirements should be compliant or with a path to compliance. All calculations should be included in the Appendix. **All tables should be updated.** The mass and power budgets should now only have 10% margins.

Please **highlight** all changes made to your ESDP from the previous version to simplify the review process (e.g. use track changes, highlight new text in a different color).

If there are any questions please email cansbx@seds.ca.

6. FINAL ESDP SUBMISSION

The CSA requires a finalized version of the ESDP prior to launch for final Flight Readiness Review (FRR) of the payload. Mass and power budgets should all have directly measured values. All requirements must be shown as compliant and **no further modifications of the payload shall be made upon submission of the final ESDP.**

Please **highlight** all changes made to your ESDP from the previous version to simplify the review process.

An unsuccessful or incomplete ESDP **will** lead to project cancellation. There is no page limit, *however clear and concise presentation will ensure no content is missed by reviewers.*

The submission date for the final ESDP is listed in Section 1.3.2.

During the Launch Campaign, an inspection or other testing may be requested to verify safety systems described in the ESDP.

7. OUTREACH ACTIVITIES REPORT

7.1. Overview

An Outreach Activities Report is to be submitted at each progress presentation and at the end of the flight campaign.

Part of CAN-SBX involves inspiring the next generation of STEM leaders, educating youth and the public on stratospheric research and space exploration and development, and communicating your work to peers in your field. Outreach activities are important for the public to understand why science is important to inform their decisions and support educational programs.

The Outreach Activities Report (OAR) is used to demonstrate that your team has made an impact on students, the public, and your peers through various activities. We encourage you to pursue a variety of outreach pathways such as interactive demos, school visits, festival exhibits, and academic presentations/posters. At least one activity must relate to your project's research and experiment. The OAR will help to strengthen SEDS-Canada's ability to continue supporting STEM education and expand the reach of the CAN-SBX project to students across Canada and help future teams increase their community impact.

7.2. Structure & Activity Record

The OAR should include a title page that lists all team members involved in the planning and delivering of outreach activities, and their specific roles, followed by the activity records. If you have photos from your event(s) and/or update photos of your payload, please also include them as attachments to the submission.

For every outreach activity you perform, please fill out an activity record using the template below. The format of the document should follow the requirements listed in Section 1.4.

Name of Event or Activity:	
Date(s) of Activity:	
Location(s) of Activity:	
Number of Team Members Involved:	

<table>
<tr><td>Was this activity related to your specific project? (Y/N)</td><td></td></tr>
<tr><td>Audience Education Level & Number of Attendees

(Circle or shade all applicable, and put a number in the box estimating the number of attendees in that category)</td><td><table><tr><td>K-4</td><td>5-8</td><td>9-12</td></tr><tr><td>Postsecondary</td><td>Educator</td><td>Other</td></tr></table></td></tr>
<tr><td colspan="2">Summary</td></tr>
<tr><td colspan="2">Briefly describe the activities conducted at the event (e.g. conference presentation, paper publication, school workshop, event booth, etc.)</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Briefly describe any feedback received from the audience or organizers.
This will help inform our best practices guide for future teams</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Briefly describe any challenges faced while planning or executing the activities.
This will help inform our best practices guide for future teams</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Please attach any photos from your outreach event(s) to the submission email</td></tr>
</table>

8. LAUNCH CAMPAIGN

For each flight, there will be a Launch Readiness Review (LRR) the morning of each launch day with all flight participants (CSA, SEDS, student teams) to determine a Go/No Go for the flight. If a No Go is determined, the next available day in the launch window is selected. The LRR includes:

- Verifying the weather conditions and flight trajectory simulations meet the requirements to launch.
- All flight train equipment and personnel are prepared.
- Transport Canada has been notified of the intent to launch.
- The payload is ready for launch.

Students are expected to arrange their own transportation to and from the launch site.

Additional details to be confirmed

9. POST-FLIGHT SURVEY

The Post-flight survey will help SEDS-Canada improve the CAN-SBX competition. We ask that all members of a team please fill out the survey and provide their feedback and opinions on how we can improve the campaign for future years.

If you included high school students during your project, please briefly describe the specific roles these students held during the project, work they have completed, and their feedback for the project and the CAN-SBX competition.

The Post-flight survey will become available as a Google Form after the flight campaign and must be submitted by the deadline listed in Section 1.3.2.

10. TEMPLATES

This section contains templates that each team should use for various parts of the project:

10.1. Mission Objectives & Success Criteria

Mission objectives (what questions do you want to answer?) and the success criteria for meeting these objectives should be specific to your experiment and quantifiable. Your success criteria should relate to the variables you will be measuring during your flight.

These should guide you as you design your payload to prioritize what systems and what capabilities should be designed/developed/tested first to meet your goals.

Table 11-1: Mission objectives & success criteria template.

Obj. #	Mission Objective	Success Criteria
1	*Ex. Demonstrate operation of solar panels in space-like conditions*	*Ex. The solar cells produce at minimum X amount of power and the panel wiring is able to distribute that power to all required components.*
2	*Ex. Demonstrate communication subsystem in space-like conditions.*	*Ex. of multiple criteria:* ● *(Minimum criteria) The ground station receives a beacon from the satellite.* ● *The satellite acknowledges reception of a ground station transmission (handshake between ground station and the satellite).* ● *The ground station receives a telemetry packet with X percentage of packet loss.*

If you know the specific success criteria but do not know what you need to record to consider the objective successful, you can write in “TBD” as a placeholder. You will be expected to finalize that criteria before the CDR.

10.2. Risk Assessment Tables

Risk tables are used to identify events that may be detrimental to your team’s ability to complete your project and guide your team in developing strategies to prevent or mitigate the risk.

A risk is assessed based on two criteria: the probability that it will occur and the severity of the consequences if it does occur. Your *Inherent Risk* is the probability and consequences of the event if you did nothing. After applying any mitigation strategies, you will then have a *Residual Risk* based on the new probability and consequences of the event, given your mitigations.

Risks should be grouped as technical (TR#), human/health (HR#), or managerial (MR#) risks. For risks that involve a safety hazard, a CSA Hazard Sheet must also be completed which may contain similar information that can be copied.

A risk matrix provides a summary of all of your risks and should be used to plan how you will monitor your risks, and prioritize which risks to address first.

Definitions	**Low**	**Medium**	**High**
Probability	Expected to occur less than once during the year, or requires multiple control elements to fail	Expected to occur once or twice during the year, or requires one control element to fail	Expected to occur multiple times during the year
Consequence *	Negligible impact to project finances, team reputation, project timeline, or the health of an individual.	Impacts the project finances, team reputation, project timeline, or the health of an individual. Would require contingency plans to be implemented to remain able to proceed, and may result in a de-scoped project.	Significant impact to project finances, team reputation, project timeline, or the health of an individual. Team is unlikely to be able to proceed further despite existing contingency plans.

*"Negligible" and "significant" are relative terms for each team. It is strongly encouraged for teams to quantify these terms and document their definitions when assessing consequences. *E.g. how much money lost would be negligible? How much would be significant to the point where the project would be unable to proceed?*

Table 11-2: Risk table template.

Risk #:	*TR1*	**Risk Name:**	*Batteries over-discharging*
Inherent Probability:	*(L/M/H) This is the probability today, with your current design or team policies*	**Inherent Consequence:**	*(L/M/H) This is the consequence today, with your current design or team policies*
Rationale:	*Provide some brief details on why you chose the probability / consequence levels. Be specific about what your consequence impacts (e.g. cost, schedule, scope, safety, reputation, student experience).*		
Mitigation Plan:	*Describe the actions to be taken to mitigate the risk, if any. This may include passive methods (e.g. re-design, elimination, deterrence/avoidance, labels) or active methods (e.g. sensors, controllers, safety mechanisms)*		
Contingency Plan:	*Describe the response plan if the hazard is realized.*		

Table 11-3: Risk assessment matrix template. List all risks (TR#, HR#, MR#) in their associated cells. Populate using your Inherent risk rankings and update to your residual risk rankings only after your mitigation strategies have been implemented.

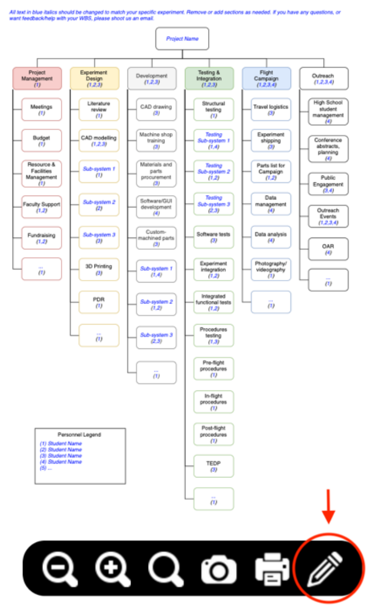
		Consequence		
		Low	**Medium**	**High**
Probability	**High**		*Risks in the "Yellow" should be mitigated and monitored to ensure they do not get worse or become realized often.*	*Risks in the "Red" should be prioritized to have mitigation strategies in place or eliminated entirely. These should be very closely monitored.*
	Medium	*Risks in the "Green" should be monitored but otherwise are acceptable*	*E.g. A power surge damages a laser unit which has a long lead time to replace. Note: this risk gets worse the later in the design process it occurs! It should be updated at the PDR and CDR stage accordingly.*	*E.g. A new team does not receive a highly competitive grant that represents the majority of their funding*
	Low	*E.g. Minor cuts from working with machined parts while wearing PPE.*		

10.3. Work Breakdown Structure (WBS)

A WBS separates your project into distinct **scopes** and assigns a person responsible for managing that scope to ensure accountability and identify gaps in personnel.

Scopes should be broken into sub-scopes which may have their own owners. Specific *activities* for each scope should be defined in the project timeline. In spacecraft design, scopes are typically defined by *system* (ex. comms, power, payload), *project phase* (ex. design, manufacturing, testing), *discipline* (ex. engineering, finances, management). A WBS usually contains multiple layers to organize your project. Each scope in the WBS should be given a number(s) corresponding to the team member(s) responsible for it.

Modify the template below (currently organized by discipline, with engineering split by timeline) to structure your project. **You can access the template at** seds.ca/templates and edit it using the buttons shown in the screenshot below.



10.4. Requirement Verification Compliance Matrix (RVCM)

The RVCM is provided in the STRATOS manual and contains the CSA design requirements which must be fully verified prior to the final ESDP report. **These must all be compliant by the final ESDP submission to fly, or a Request for Deviation must be completed and approved.**

A sufficiently comprehensive RVCM demonstrates that your design is safe to fly and the evidence provided should be detailed enough to allow a duplicate payload to be produced.

An example line is shown below. Use the following to fill in the 3 columns in the RVCM:

Compliance Column: C = Compliant, P = Partially Compliant, N = Non-Compliant, N/A = Not applicable. *For the PDR and CDR stage, if a requirement is currently non-compliant, but is intended to be compliant, please mark it as C with the justification and reference indicating the upcoming work to be performed to reach compliance.*

Justification column: brief explanation for how the payload complies to that requirement, or why the requirement is not applicable.

Reference column: analysis, test report, etc. that proves compliance to the requirement (e.g., reference the Analyses and Calculation section of your ESDP or other sections, as required)

REQ ID	Requirement	Compliance	Justification	Reference
PLD-REQ	The payload shall demonstrate a	*C, P, N, or*	*Examples:*	*Example: Section X*

-MEC-001	positive margin using a safety factor of 2 for the separation loads: a vertical downward G-force of 10G and a lateral G-force of 7.5G in any direction in the XY plane applied to the payload's center of mass.	*N/A*	*Simulated in CAD model* *Tested system by dropping from a height of 3 m and stopping using a rope.*	*in ESDP.*

10.5. Mass and Power Budgets

Your experiment is expected to have more components than the sample budgets below. Do not forget to include masses for your fasteners, wiring, and mounting interface to the gondola.

At the proposal stage, your margin should be over 15% and you should have a plan to reduce mass in case your system exceeds the budget at later stages. Please use the following nomenclature for the type of estimate:

E Estimated mass/power (typically +/- 15-25%)

M0 Calculated using a 3D solid model or modelling software (SolidWorks, Eagle, etc.)

M1 Taken from a manufacturer spec sheet

M2 Measured (using a scale, voltmeter, ammeter, etc.)

Table 11-4: Mass budget template.

Component	Est. Typ.	Qty	Unit [g]	Total [g]	Mass Frac.	Remarks
Structure & Mechanisms			***Subtotal***	900	52%	
Structure	M2	1	600	600		Aluminum 6061-T4
Brackets	M2	15	20	300		
Payload			***Subtotal***	500	29%	
Camera	M1	2	250	500		High-speed, #PN
Power System			***Subtotal***	84	5%	
Batteries	M2	4	15	60		Lithium ion
9V Power Adapters	M2	3	8	24		

Data Handling			***Subtotal***	160	9%	
Data Logger	M2	1	110	110		
Arduino UNO	M0	1	50	50		
Miscellaneous			***Subtotal***	80	5%	
Cabling	E	1	50	50		
Fasteners	M0	1	30	30		
Target Mass [g]		**Total Mass [g]**			**Margin**	**Remarks**
2000		1725			14%	

Table 11-5: Power budget template.

Component	**Est. Typ.**	**Qty.**	**Experiment Operational Mode** *(Add more as needed)*					
			Idle (1 hr)			**Science (2 hr)**		
			Tot. Power [W]	**Duty Cycle**	**Tot. Energy [Wh]**	**Tot. Power [W]**	**Duty Cycle**	**Tot. Energy [Wh]**
RF Module	E	4	0	0%	0	0.68	100%	1.36
Arduino	M1	2	5	50%	2.5	10	100%	20
Total Power/Energy Used			5	--	2.5	10.7	--	21.36
Power/Energy Available or Allocated			20		4	20		23.5
Margin			75%		37%	47%		9%
Est. Depth of Discharge (at end of flight)*			88% *For the proposal, this may be left as TBD*					

**Note that your batteries will be experiencing low temperatures which will significantly reduce capacity unless you have a thermal control system. This should be taken into consideration when deciding on the number of batteries, charging systems, and/or thermal control.*

10.6. Budget and Funding

Using your WBS as a guide, complete a table listing the costs of each major scope of the project. This table is not exhaustive and should be modified to suit your needs. Include all current and future sources of funding to estimate total available funds and determine the overall project budget. Include as many details as possible.

Note at the proposal stage, you will not have any actual spendings yet. At later stages, please update your actual spendings and forecasts for future spending as needed.

Table 11-6: Budget and funding table template.

Scope	Sub-Scopes	Expenses ($CAD)	
		Estimated Expenses	**Actual Expenses**
Project Management	Meetings		
	Subtotal		
Design & Prototyping	CAD Model		
	Prototype		
	Subsystem 1		
	Subtotal		
Manufacturing	Machining		
	Training		
	General Equipment		
	Spare Parts		
	Subsystem 1		
	Subtotal		
Assembly Integration & Verification and testing	Drop Test		
	Software Test		
	Subsystem 1		
	TVAC Chamber		
	Subtotal		
Flight Campaign	Flights		
	Car Rental		

	Food		
	Shipping		
	Accomodations		
	Subtotal		
Outreach	Conferences		
	Events		
	Subtotal		
Total Cost		*Total all costs together here*	
Total + 15% Margin		*Add 15% margin to your total cost here*	

Type of Funding	**Name of Source**	**Funding ($CAD)**	**Risk %**	**Est. Funding ($ x Risk %)**	**Notes**
Grants	University	*Amount of funding*	*How likely are you to get this amount?*	*Risk-adjusted amount*	
	Government				
Sponsors	Companies				
Donations	Person				
Maximum Funding		*Total all funding sources together*			
Risk-Adjusted Funding		*Total all risk-adjusted funding sources together*			
Risk-Adjusted Deficit / Overture*		*Risk-adjusted funding minus your total cost +15% margin*			

*This helps provide a picture of how much additional funding or cost-cutting you should be pursuing to remain confident you are able to fund your project.

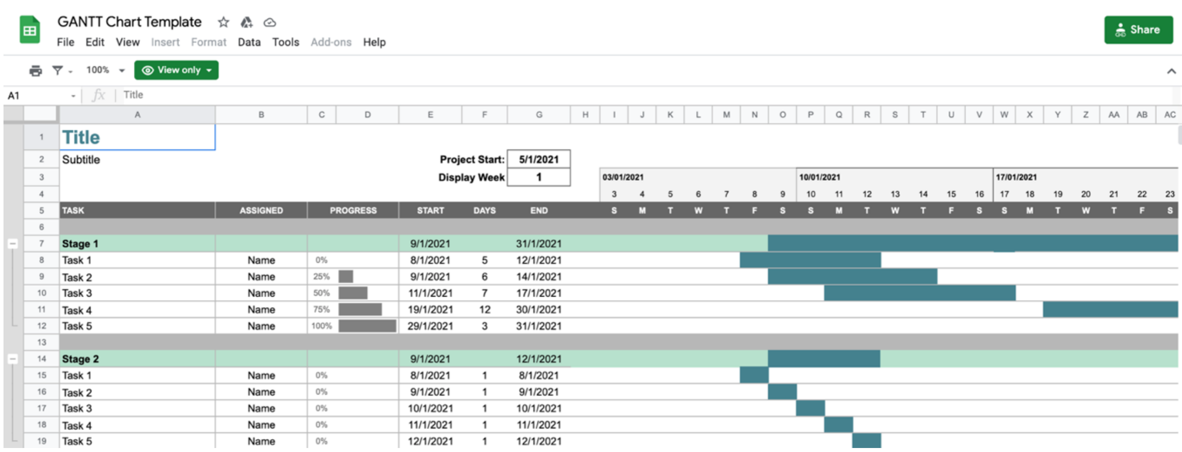
10.7. Hazard Sheet

Please review Section 5.1. of STRATOS Expandable Balloon Payload Requirements and User's Manual for a list of hazards that must be identified and reported in Hazard Sheets. The Hazard Sheet template can be found [here](#).

10.8. Gantt Chart Template

A Gantt chart is used to illustrate a project's schedule to help ensure your project stays on schedule and to foresee any timeline issues that may come up.

To create your own Gantt Chart using our Google Sheets template, head to **[seds.ca/templates](#)** and scroll to the bottom of the page. You should see a red button which will direct you to a copy of the template. To create your own chart, click File > Create a Copy. It will save an editable version of the Gantt chart in your Google Drive.



Some instructions for using the chart:

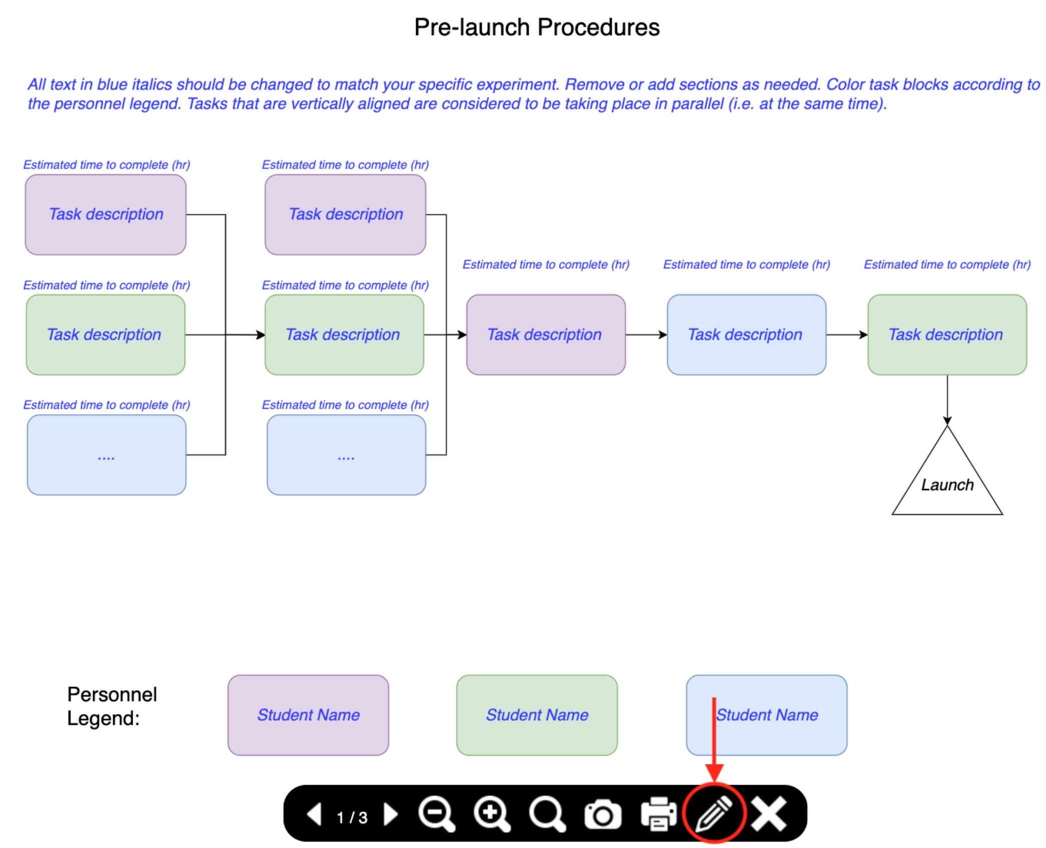
- When adding a task, specify the start date and the number of days you expect to complete it. The end date and task bar will then auto-populate.
- If you adjust the number next to *Display Week*, the calendar will shift left or right as it changes the week from which to start displaying information. This functionality is also useful near the beginning of the project, where you have only rough, longer-term estimates for task completion.
- To the left of the row numbers there are buttons to expand and collapse stages of the project. For example, if you press '-' next to row 7 or row 21 you can hide tasks related to stages 1 or 3, respectively.
- If you add a number in the left side of the *Progress* column the progress bar will auto-update

This template was created by Sam Aberdein and Nicole Richardson.

10.9. Pre-launch, In-flight, and Post-flight procedures

Use following flowchart templates to visualize pre-launch, in-flight (if applicable), and post-flight recovery procedures. **You can access the template at seds.ca/templates**. Add or remove tasks (sections) as needed based on your procedures. Write the estimated amount of time each part of the procedure will take. Also identify the personnel responsible for each task, and note that tasks that are stacked vertically are tasks that can occur in parallel.

When accessing the template at seds.ca/templates, you can edit the flowchart using the edit buttons shown in the screenshot below. It will open a new page in draw.io, where you can edit the flowchart without modifying the template.



Although the above screenshot shows only the pre-launch procedures, all three flowcharts are included in the draw.io file as separate tabs.

10.10. Faculty Letter of Endorsement

SEDS-ÉEDS CANADA | Students for the Exploration and Development of Space
Étudiants pour l'Exploration et le Développement Spatial

Canadian Stratospheric Balloon Experiment Design Challenge (CAN-SBX)

Letter of Endorsement

To SEDS-Canada,

This letter is to certify that I, ____ will serve as Faculty Advisor to Team _______________________________________, and I understand that I will be asked to provide guidance and support through some or all of the phases of the challenge, including submission of the project Proposal, Preliminary Design Review, Critical Design Review, and Test Equipment Data Package.

Faculty Advisor Signature: ____ Date: ______________

Faculty Advisor Information

Name: ____

E-mail: ____

Affiliation/Department: ____

Is this the primary Faculty Advisor? (circle) Yes No

Team Information

Team Name: ____

Team Lead Name: ____

Team Lead E-mail: ____

Affiliation/Department: ____

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