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CSA-STRATOS-MAN-0011

Canadian Space Agency
Stratospheric Balloons Program

STRATOS Expandable Balloon Payload User's Manual

Rev C Draft

February 13, 2023

Canada

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Revision History

Rev.	Description	Date	Initials
I.R.	Initial release	Jan. 20, 2020	AR
A	- Updates to the requirements and guidelines. - Updates to the payload deliverable (documentation) requirements. - Inclusion of a RFD/RFW Form and a Recovery Procedure Template in the appendices.	Dec. 07, 2020	AR
B	- Generalization of the document to be applicable to a broader spectrum of potential payload or payload gondola applicants. - Re-organization of the overall document structure and the document's sections, including separating the Requirements and Best Practices / Design Guidelines into different sections. - Modification of the payload requirements as follows: modified PLD-REQ-MEC-001, PLD-REQ-MEC-005, added new PLD-REQ-MEC-020B, PLD-REQ-MEC-030B, modified PLD-REQ-MEC-040A, added new PLD-REQ-MEC-040B, modified PLD-REQ-ELE-001, PLD-REQ-ELE-10, PLD-REQ-ELE-020, added new PLD-REQ-ELE-023, deleted PLD-PROC-REQ-001, modified PLD-REQ-PROC-010, PLD-REQ-SAF-001, added new PLD-REQ-SAF-005, deleted PLD-REQ-SAF-010, modified PLD-REQ-SAF-020, deleted PLD-REQ-SAF-025, added new PLD-REQ-SAF-027, modified PLD-REQ-SAF-030, PLD-REQ-SAF-035, added new PLD-REQ-SAF-037, modified PLD-REQ-SAF-040, deleted PLD-REQ-SAF-050, added new PLD-REQ-SAF-055. - Addition of information about the SEB aerostat and the different types of aerostat configurations (integrated & distributed). - Removed information regarding the required contents and submission process of the ESDP, (now included in CSA-STRATOS-PR-0004 instead). - Removed the following templates: Requests for Deviation, Hazard Sheets, and Recovery Procedures (all now included in CSA-STRATOS-PR-0004 instead).	Dec. 14, 2021	AR
C	- Removed payload requirements (now included in CSA-STRATOS-RD-0017 instead). - Added further recommendations in Section 6 Design Guidelines and Best Practices. - Added further information regarding countdown and launch in Section 7. - Modified Appendix on Mechanical ICD		

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1 INTRODUCTION

The Canadian Space Agency (CSA)'s stratospheric balloon program, Stratos, was created in 2011 in collaboration with the Centre National d'Études Spatiales (CNES). This program provides opportunities for Canadian academia and industry to test, validate, and demonstrate new technologies and scientific experiments at an altitude where only balloons can be operated. Stratos contributes to the training and development of a highly qualified workforce: the next generation of Canadian engineers and scientists.

Balloon campaigns alternate between locations, typically coming to Canada every other year. Up until 2018, these Canadian balloon campaigns were centered exclusively around the CNES Zero-Pressure balloon (ZPB) aerostats, even though CNES also has a light expandable balloon (ballon léger dilatable or BLD) business line.

Stratospheric Expandable Balloons (SEBs) are unmanned and usually filled with helium. The balloon carries scientific experiments and payloads (PLs) or payload gondolas (PLGs) to a "near-space" altitude of 20 to 35 km. The aerostat may also contain electronic subsystems required for tracking and operations.

1.1 PURPOSE

The purpose of this document is to provide information regarding the CSA SEB program, for payload developers to have a successful SEB flight.

1.2 SCOPE

This document provides information regarding campaigns, typical launch and flight phases, and guidelines, best practices and recommendations.

For information regarding payload requirements, refer to AD1. For information regarding the payload application and certification process, including the deliverables to be submitted to the CSA, refer to RD3.

1.3 ACRONYMS

AD	Applicable Document
AIT	Assembly Integration and Testing
CAR	Canadian Aviation Regulations
CM	Centre of Mass
CNES	Centre National d'Études Spatiales
CoC	Certificate of Compliance
CSA	Canadian Space Agency
ESDP	Experiment Safety and Data Package
ICD	Interface Control Document

PI	Principal Investigator
PL	Payload
PLG	Payload Gondola
RD	Reference Document
RF	Radio Frequency
RFD	Request for Deviation
RFW	Request for Waiver
S&MA	Safety and Mission Assurance
SBD	Short Burst Data
SEB	Stratospheric Expandable Balloon
TOC	Table Of Contents

2 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents of the exact issue date and revision level shown are applicable and form an integral part of this document to the extent specified herein. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence.

TABLE 2-1 APPLICABLE DOCUMENTS

AD No.	Document No.	Document Title	Rev. No.	Date (YYYY-MM-DD)
AD1.	CSA-STRATOS-RD-0017	Expandable Balloon Payload Requirements Document	IR	2023-02-08
AD2.				
AD3.				

2.2 REFERENCE DOCUMENTS

The following documents provide additional information but do not form part of this document.

TABLE 2-2 REFERENCE DOCUMENTS

RD No.	Document No.	Document Title	Rev. No.	Date (YYYY-MM-DD)
RD1.	CSA-STRATOS-DD-0004	Expandable Balloon Aerostat Architecture and Design Document	Latest	
RD2.	SOR/96-433	Canadian Aviation Regulations (En) (Fr)	Latest	
RD3.	CSA-STRATOS-PR-0004	Payload and Payload Gondola Certification and Experiment Safety Data Pack Submission Procedure	Latest	
RD4.	CSA-STRATOS-FORM-0010	Stratospheric Expandable Balloon Payload Application Technical Questionnaire	Latest	

3 STRATOSPHERIC EXPANDABLE BALLOON (SEB) OVERVIEW

High altitude balloons are commonly used for weather soundings, but in the case of the CSA's Stratospheric Expandable Balloons (SEBs), they are used to transport scientific payloads to the stratosphere. The system is multi-mission and reusable (with the exception of the balloon envelope).

3.1 SEB CATEGORIES

According to Canadian Aviation Regulations (CARs) [RD2], unmanned free balloons are classified into two categories: *Small* and *Large*. They are classified according to the volume of gas contained in the balloon on the ground. If a balloon has a gas carrying capacity greater than 115 ft^3 (3.256 m^3), it will be considered as a *Large* unmanned stratospheric balloon. When falling in the *Large* balloon classification, the SEB aerostat must include a certified transponder for in-flight tracking. Note also that as soon as a transponder is included, the aerostat is automatically considered to be *Large* regardless of the gas carrying capacity.

3.2 CSA SEB AEROSTAT

A short description of the CSA's SEB aerostat is included in this section. For more detailed information, refer to the SEB Aerostat Architecture and Design Document [RD1].

Figure 3-1 depicts the possible CSA SEB aerostat configurations, which always include the following:

- **Envelope**: a latex balloon that has the ability to continually expand as outside pressure decreases to the point of balloon rupture.
- **Attachment & Connecting Cords:** nylon loops of cord to attach the envelope to the rest of the aerostat via swivels.
- **Parachute**: the parachute system which allows for the non-lethal descent of the gondola.
- **Mechanical Hardware:** swivels and threaded links used to connect the different elements of the system together. May also include eyebolts, nuts and washers.

Depending on the configuration, the flight train, which includes all elements connected to the envelope via the connecting cords, may also include the following:

- **Avionics Gondola**: a structure provided by the CSA that houses the electrical subsystems needed for in-flight tracking and ground recovery, including a transponder and a GPS receiver as described in further details below (refer to AD1 for the prohibited payload / payload gondola RF emissions):
    - o A certified transponder replying to both legacy Mode A/C and Mode S interrogations from both ground radar and airborne collision avoidance systems is used as the primary method of in-flight tracking. The transponder is also equipped to transmit ADS-B signal. The transponder transmits the identification and location of the aerostat throughout the flight.
    - o A separate secondary tracking system, using a GPS receiver and Iridium's Short Burst Data (SBD) service, in order to identify the landing location and recover the flight train. The device provides tracking capabilities and ancillary telemetry from

the gondola such as: latitude, longitude, altitude, speed, heading, atmospheric pressure and temperature.

- **Separator**: a self-terminating linkage between the envelope connecting cord and the parachute that will separate the system upon balloon rupture.
- **Flight Tracker:** a unit enabling flight tracking and ground recovery, used when the Avionics Gondola is not part of the flight train.
- **Payload Bay:** a supporting structure integrated to the Avionics Gondola designed to accommodate one or more payload(s), as per Figure 3-2.
- **Payload Gondola (PLG)**: a standalone supporting structure hosting one or more payload(s) and provided by an organization external to the CSA.

For the *Large* category, two possible payload configurations are available depending on the user's needs:

1. In the **Distributed Configuration**, the payload is located in its own standalone payload gondola (PLG) which is designed and provided by the external payload organization. Therefore, the Avionics Gondola and the Payload Gondola are distinct elements with the former located above the latter in the flight train and connected using mechanical links.
2. In the **Integrated Configuration**, the payload is integrated into the CSA-provided gondola and so the Avionics Gondola and Payload Gondola are united into a single element. In this configuration, the concept of a payload gondola does not exist, it is instead called a Payload Bay. Again, the Avionics Gondola is located above the Payload Bay.

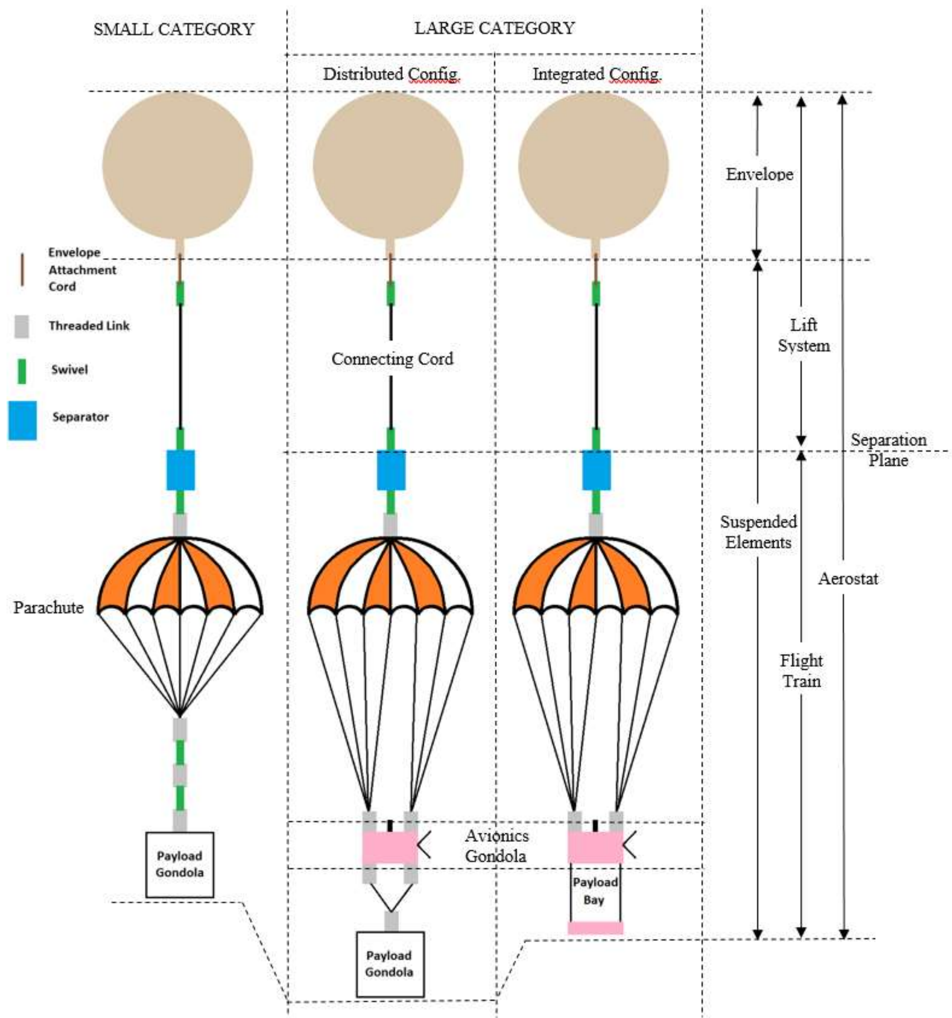


FIGURE 3-1 – SEB AEROSTAT CONFIGURATIONS

The CSA Payload Bay volume can be seen in the following Figure.

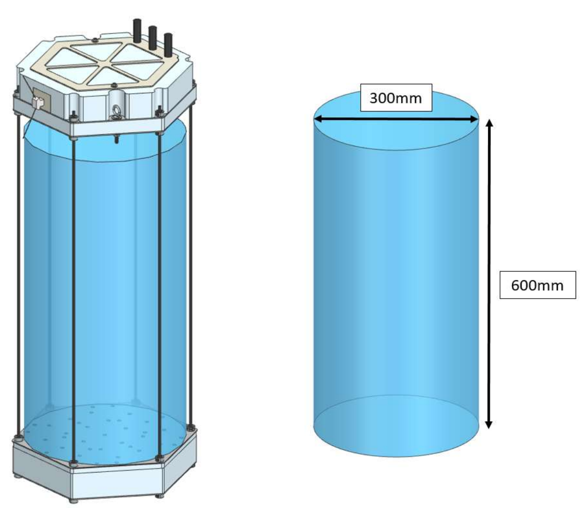


FIGURE 3-2 PAYLOAD BAY VOLUME (INTEGRATED CONFIGURATION)

4 LAUNCH AND FLIGHT PHASES

This section describes the phases of a SEB flight. Flight missions are fairly simple and of short duration, lasting in the order of 2 to 4 hours, and consisting of an ascent, balloon burst/flight train separation and a descent under parachute. It is important to note that SEB flights are uncontrolled, i.e., ground operators have no control over the trajectory, flight duration or burst altitude.

4.1 TRANSPORTATION AND SHIPPING

Payload developers are responsible for the transportation or shipping of their payload to and from the launch site. They are also responsible for the transportation of any necessary pre-flight testing and integration tools and equipment (ground support equipment) to the launch site. It is recommended that payloads are packaged in a way to minimize the risk of damage during transportation or shipping.

4.2 PRE-LAUNCH

The launch window will be determined by the CSA in advance. Starting a few days before the opening of the launch window, the CSA will check weather conditions daily and perform daily flight trajectory simulations in order to predict the best day(s) for a flight opportunity. The morning of the launch day, the CSA will confirm an initial Go or No Go for a flight that day based on the weather conditions and the flight trajectory simulation.

During the campaign and prior to the launch, the payload's Principal Investigator (PI) is responsible for performing any necessary inspections and tests of their PL or PLG. The CSA will perform a visual inspection to validate that the payload is compliant to its Experiment Safety and Data Package (ESDP), refer to RD3 for details regarding the creation, submission and approval of an ESDP. In some cases, the inspection may also require an experimental demonstration.

The day before the launch, the payload will be integrated within the Payload Bay (integrated configuration) or the payload gondola will be integrated within the flight train (distributed configuration) and inspected. The CSA will perform a visual inspection of the entire flight train to validate that the PL or PLG integration is compliant to the CSA's flight train Safety Data Package (SDP). If compliant, the CSA will issue a Certificate of Compliance (CoC) authorizing the payload as safe for the flight.

4.3 FLIGHT

4.3.1 Countdown and Launch

The following countdown chronology is given as an indication. The actual timing and duration of events may vary.

<u>Launch-2hr</u>: Weather briefing

Prior to beginning the countdown, the CSA will perform a final review of the weather forecasts and the simulated flight trajectory to make sure it is still acceptable to launch.

<u>Launch-1hr45</u>: Set-up

The CSA will then proceed with the final assembly and integration of the flight train.

<u>Launch-1hr</u>: Payload transfer

The payload gondola is transferred to the launch sites and the final checks are carried out.

Lanch-0hr45: Envelope inflation

After the confirmation of the correct operation from all those involved, the CSA will begin balloon inflation. No further interventions are possible on the payload gondola.

Launch:

After the balloon inflation is completed, the aerostat is fully integrated and the CSA has obtained a Go for launch, the payload gondola is held by a CSA operator and is released to begin the flight.

4.3.2 Ascent, Burst, and Descent

The aerostat will ascend at a typical average speed of 6 m/s. Depending on the burst altitude and on variations in ascent speed, ascent takes approximately 1 to 2 hours. The aerostat will experience oscillating movement during the ascent.

The balloon will typically burst around 30 km altitude (burst altitude depends on several factors). However, there is no control over the flight termination and the balloon may burst at an altitude lower or higher than 30 km.

After the balloon bursts, the flight train descends under a parachute. Due to the thin atmosphere in the stratosphere, the descent speed is high at the beginning. The descent speed will stabilize at around 7-8 m/s closer to the ground. The descent takes approximately 30 minutes to an hour.

For the entire duration of the flight, the position of the aerostat (altitude, longitude and latitude) will be tracked using the equipment contained within the avionics gondola (refer to Section 3.2 for more information).

4.4 LANDING

The maximum permissible terminal (landing) velocity is 6.32 m/s. Maximum expected accelerations at landing are 15G axially and 5G laterally.

The gondola may become suspended in trees during landing, or it may land on the ground. The gondola's orientation may also be on its side or upside down at landing. Risks include landing in bodies of water, and rain conditions after landing and prior to recovery. Open fields are preferable landing locations, however, landing in densely wooded or swampy areas may occur.

4.5 RECOVERY

The payload gondola and flight train will be recovered from the landing site by the CSA. A truck will then carry the gondola and payload back to the launch base. The transport can cause vibrations which should be taken into account in the PL or PLG design. The goal is typically for a same day or next day recovery. However, in the case of bad weather conditions, low visibility at the recovery site, or other non-typical circumstances, recovery may be delayed. Any time-critical item must be reported to the CSA in advance.

Only the CSA personnel will participate in the recovery operations. Members of the payload team may come to a rendezvous point near the landing site for PLs or PLGs that require time-sensitive operations post landing, but they will not be permitted at the landing site due to a lack of appropriate training and PPE.

The payload developer will provide a recovery procedure as part of their ESDP submission prior to the flight campaign. This will include details of how the recovery crew should handle and maintain the safety of payload equipment. A template recovery procedure is provided in RD3.

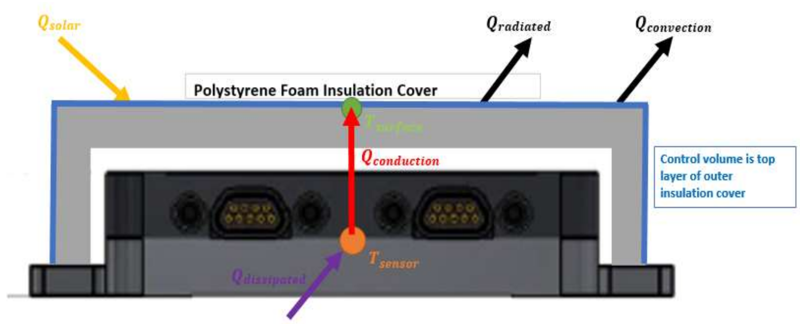
5 PAYLOAD DESIGN GUIDELINES AND BEST PRACTICES

This section summarizes recommended design guidelines and best practices. The intent of this section is to include information that can help maximize payload mission success. Implementing these recommendations is not mandatory. Payload developers can choose to follow any or all of these recommendations based on their payload mission requirements and their level of risk tolerance for the mission success.

5.1 ENVIRONMENTAL DESIGN GUIDELINES AND BEST PRACTICES

Thermal

- It is recommended as a first step to perform a 1D heat balance of the system prior to starting any detailed thermal analysis. This allows for a comparison of the thermal analysis results with the analytical calculations to help validate the thermal analysis. If both analyses correlate well, the 1D heat balance can be used to rapidly test different thermal coating options prior to running any simulations. Results can be validated by testing. Refer to the Figure 5-1 below for an example 1D heat balance calculation that considers a layer of insulation. A similar calculation could be performed to obtain a first approximation for the temperature of the payload.



$$Q_{in} = Q_{out}$$

$$Q_{conduction} + Q_{solar} = Q_{radiated} + Q_{convection}$$

$$\frac{kA}{L}(T_{sensor} - T_s) + \alpha * q''_{solar} * A = \varepsilon\sigma A(T_s^4 - T_{space}{}^4) + \varepsilon\sigma A(T_s^4 - T_{Gondola}{}^4) + hA(T_s - T_{Air})$$

But, $$Q_{dissipated} = Q_{conduction} = \frac{kA}{L}(T_{sensor} - T_s)$$

$$T_s = T_{sensor} - Q_{dissipated} * \frac{L}{kA}$$

Substituting back

$$Q_{dissipated} + \alpha * q''_{solar} * A = \varepsilon\sigma A\left(\left(T_{sensor} - Q_{dissipated} * \frac{L}{kA}\right)^4 - T_{space}{}^4\right) + \varepsilon\sigma A\left(\left(T_{sensor} - Q_{dissipated} * \frac{L}{kA}\right)^4 - T_{Gondola}{}^4\right) + hA\left(\left(T_{sensor} - Q_{dissipated} * \frac{L}{kA}\right) - T_{Air}\right)$$

Solve Iteratively

FIGURE 5-1 – EXAMPLE 1D HEAT BALANCE CALCULATION

- It is recommended to test the payload in a thermal environment that includes margin on the temperature range experienced during the flight (i.e. test at lower and higher temperatures than the minimum and maximum flight environment temperatures).

Radiation

- Radiation is not considered to be significant for the flight altitude and short flight duration of Stratospheric Expandable Balloon flights.

Outgassing

- Outgassing is not considered to be significant for short duration flights. However, volatiles may affect measurements for some high precision instruments. It is recommended to apply best practices for vacuum conditions when choosing materials.

Depressurization

- In order to ensure unsealed enclosed spaces can properly vent during depressurization, it is encouraged to maintain a sufficient Maximum Effective Vent Ratio (MEVR), as defined below:

  For a sufficient MEVR, $$\boldsymbol{MEVR = \frac{Enclosed\ Volume\ (cm^3)}{Effective\ Vent\ Area\ (cm^2)} \leq 5080\ cm}$$

  Effective Vent Area here denotes the sum of areas of **unobstructed** openings to the enclosed volume.

5.2 ELECTRICAL DESIGN GUIDELINES AND BEST PRACTICES

Payload Power System

- The design and capacity of the payload power system should take into consideration time for testing of the payload prior to launch, as well as a potentially prolonged countdown and extended flight time. The payload power system should be sized in order to accommodate the typical pre-launch countdown period of 1 hour, as an addition to the flight duration of 2 to 3 hours.
- Energy storage units should include a passivation system such as an arming/disarming plug or an ON/OFF switch in order to easily turn the payload on and off during ground handling and recovery. An example of an arming plug can be seen in Figure 5-2**Error! Reference source not found.** below. As per this schematic, when the arming plug is disconnected, the payload ("load") is not connected to the battery and is therefore OFF. When the arming plug is connected, the payload ("load") is connected to the battery since the arming plug shorts pin 7 to 2 and pin 6 to 1 and the payload is ON. The connector should be located on the outside of the enclosure so that before launch the arming plug can be easily connected to turn the payload on and during recovery the arming plug is simply removed to remove power from the payload (this is an Apply Before Flight system instead of a Remove Before Flight system). Note that the arming plug connector must be rated for the maximum current of the battery.

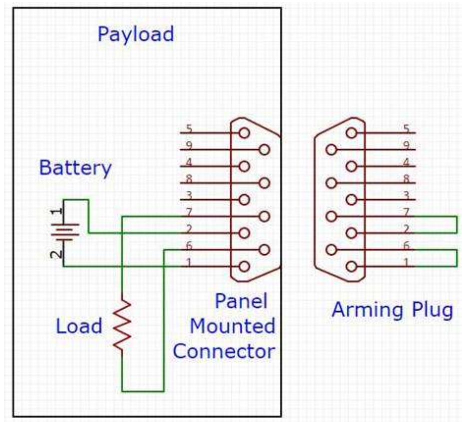


FIGURE 5-2 – PAYLOAD ARMING PLUG EXAMPLE

Electromagnetic Compatibility and Electrostatic Discharge

- All equipment should minimize electromagnetic emissions, as well as be immune against electromagnetic interference (EMI) from within the gondola and from external sources. Components that are sensitive to EMI should be shielded.
- Electrostatic Discharge (ESD) is the flow of electricity between two electrically charged objects, such as static electricity caused by induction, which can damage parts of equipment. ESD protection should be considered within the payload design, and best practices should be followed, such as those found in the following link: https://workmanship.nasa.gov/lib/insp/2%20books/links/sections/11-01%20General%20Requirements.html.

Wiring Harnesses and Connectors

- All wiring harnesses should be protected against any potential usage or environmental damage and should be supported by flexing at the breakouts to avoid overstressing of the wires.
- Harnesses should provide slack to prevent against mechanical strain (sharp turns or pulling), to allow the replacement of terminations and to permit shifting during maintenance operations.
- Splices should be avoided. If splices need to be used, they should follow standard workmanship practices such as those found in the following link: https://workmanship.nasa.gov/lib/insp/2%20books/links/sections/407%20Splices.html.
- Connectors should be protected against deterioration using connector savors.
- Connector caps should be installed on external connectors whenever they are not in use.

5.3 MECHANICAL DESIGN GUIDELINES AND BEST PRACTICES

- It is strongly suggested to protect the payload equipment against ingress of dust and water in case there is rain at the landing site or the gondola lands in water. However, the payload will see atmospheric pressures as low as 3 hPa, so it is important that any sealed volumes in the payload are designed to handle the pressure difference at max altitude.

- If any cameras or optical instruments are used, make sure to verify that the field of view (FOV) will not be obstructed once the payload has been integrated in the gondola (e.g. by the gondola's carbon fiber rods).
- Foam is a highly suitable material to enclose payloads owing to its low density, thermal insulation, compressibility, affordability, availability, and manufacturability. However, the payload must have a robust system to connect the foam to the payload or to the interface plate to ensure it remains in place. We recommend medium density foams, such as extruded polystyrene.
- For an integrated configuration, it may be necessary to add straps holding the payload to the bottom of the gondola, so it is important to leave room on the top surface of the payload (or its enclosure) for the straps if the payload is not bolted to the interface plate.

5.4 ASSEMBLY, INTEGRATION, TESTING (AIT) AND OPERATION DESIGN GUIDELINES AND BEST PRACTICES

It is very important during the payload design phase to keep in mind the assembly, integration, testing (AIT) and operation activities that need to take place before the flight in order to make these activities easier.

- It is recommended to include LEDs that are external to the payload enclosure and that remain visible after the payload has been integrated in the gondola. These should be designed in order to rapidly determine if the payload is functioning nominally once it is turned on without having to open the payload enclosure. Different LEDs could be used to communicate different statuses (ex. green = payload on and nominal, red = computer anomaly, blue = communication system anomaly, etc.).
- It is recommended to design for payload accessibility. This means thinking about providing easy access to any parts of the payload that may need to be accessed for testing, debugging, or arming after the payload has been assembled and integrated in the gondola. Some examples include:
  - If re-chargeable batteries are used, it is recommended to include a charging connector which is accessible externally after the payload has been integrated in the gondola. This is to allow charging of the payload batteries if needed between payload integration and the launch.
  - If non-rechargeable batteries are used, it is recommended to have an easily accessible method of installing and removing battery cells after the payload has been integrated in the gondola. This is to allow battery cells to be replaced if needed between payload integration and the launch.
  - It is recommended to include a de-bug connector which is accessible externally after the payload has been integrated in the gondola. This is to allow the payload to easily be connected to a laptop for monitoring / de-bugging as required before the flight.

- Payloads should provide their own set of tools and spare parts as required for any testing and integration before the flight. Generic test equipment availability should be coordinated with the CSA in advance. Specialized testing equipment is the responsibility of the payload.

APPENDIX A MECHANICAL ICD – INTEGRATED CONFIGURATION

In the Integrated Configuration, the payload mounts to an interface plate below the avionics gondola, thus, it is physically attached from below. The interface plate is necessary to attach the payload to the SEB payload bay.

Payloads can either request to use one of the two available generic CSA interface plates or to create their own interface plate. The interface plate, as well as any fasteners used to attach the payload to it, must always be included in the total payload mass.

All interface plates must have 6 clearance holes to allow the gondola's carbon fiber (CF) rods to pass through. Each plate will be secured to the base of the gondola with 6 collars, which are centered on the CF rods and are secured on top of the interface plate. Each of these collars has a 20mm-diameter "collar keep out zone" that must be respected by the payload – no payload components may enter this zone, at any height in the payload bay, without first obtaining permission of the CSA.

A.1 CSA GENERIC INTERFACE PLATES

The CSA has designed and produced two different generic interface plates for the SEB Payload Bay. These plates are made of Aluminum sheet metal and have a number of rivet nuts inserted into them to allow payload fasteners to secure the payload to the interface plate. Note that all rivet nuts are of size M4-0.7 x 9mm and so payloads must use appropriately sized fasteners with clearance holes to mate with the rivet nuts.

A.1.1 CSA Interface Plate 1 – No Nadir View

The first CSA interface plate is a solid plate, i.e. it does not have a central view port that would enable the payload to have a nadir view. Its mass, including the rivet nuts, is 350g.

This interface has three different hole patterns for payloads to use: one rectangular and two circular. All three patterns are centered on the center of the plate. The rectangular hole pattern is a 5x5 grid with a spacing of 50mm between rows and columns of the grid. The two circular hole patterns each contain 6 holes and have diameters of 275mm and 150mm. Note that the 150mm hole pattern is angularly aligned with the rod clearance holes whereas the 275mm pattern is offset by 30° from the rod clearance hole pattern.

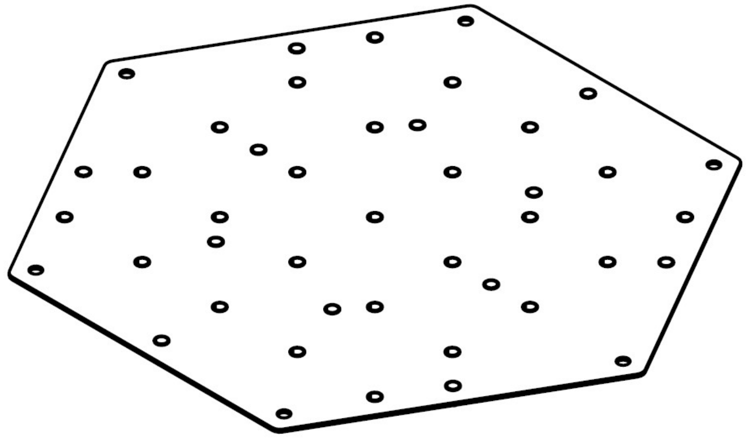


FIGURE A5-3 – CSA INTERFACE PLATE 1 – ISOMETRIC VIEW

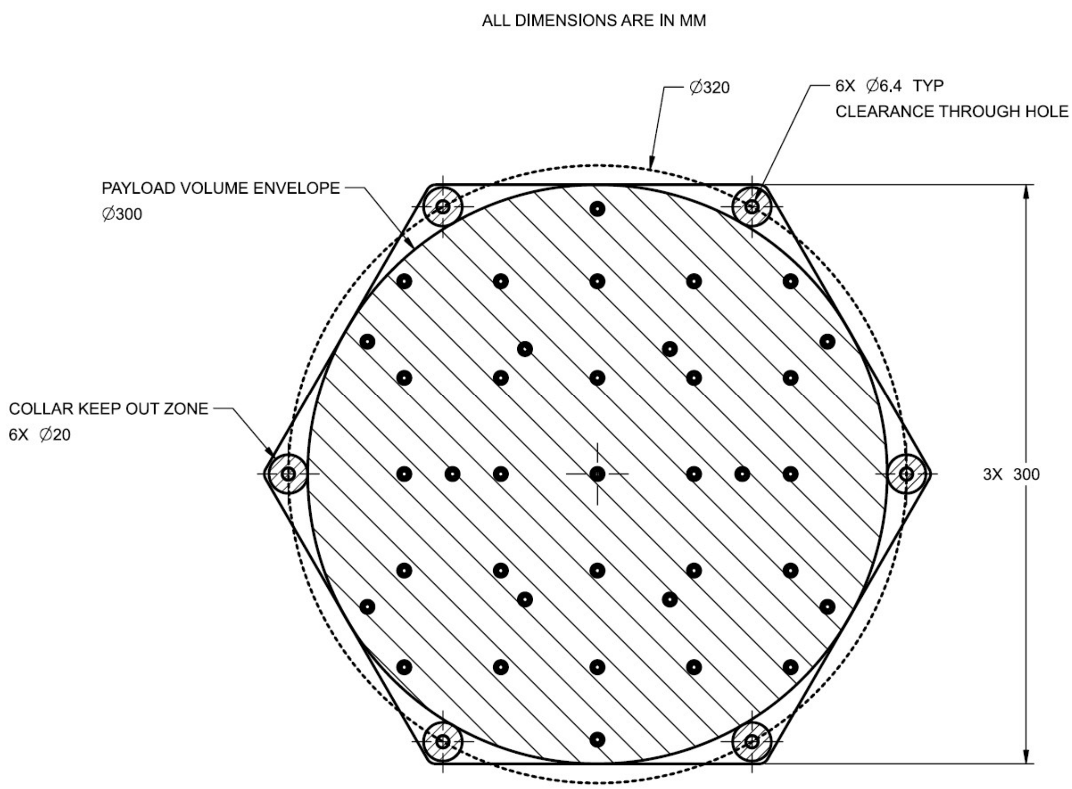


FIGURE A5-4 – CSA INTERFACE PLATE 1 – PAYLOAD VOLUME ENVELOPE AND COLLAR KEEP OUT ZONES

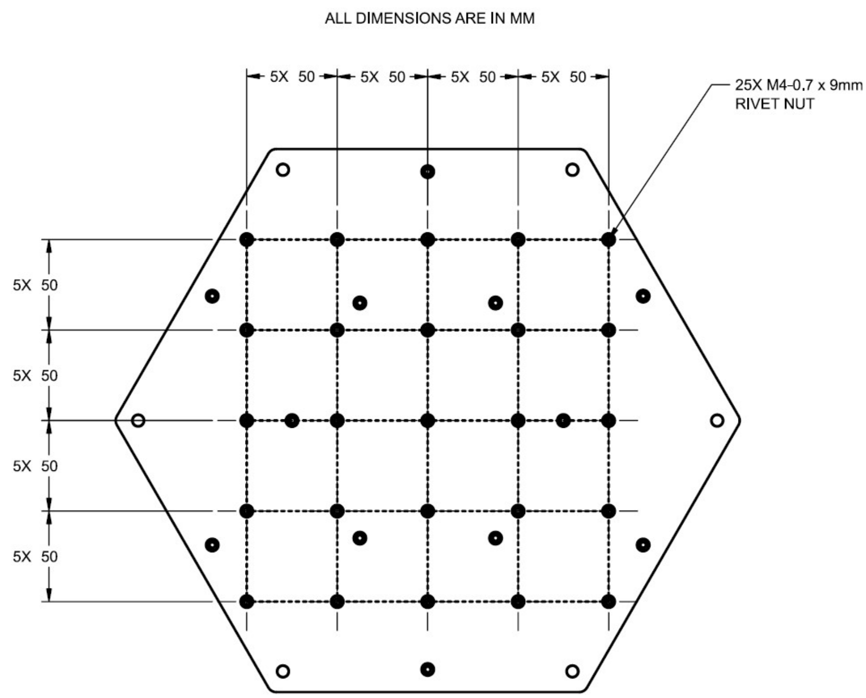


FIGURE A5-5 – CSA INTERFACE PLATE 1 – RECTANGULAR BOLT PATTERN

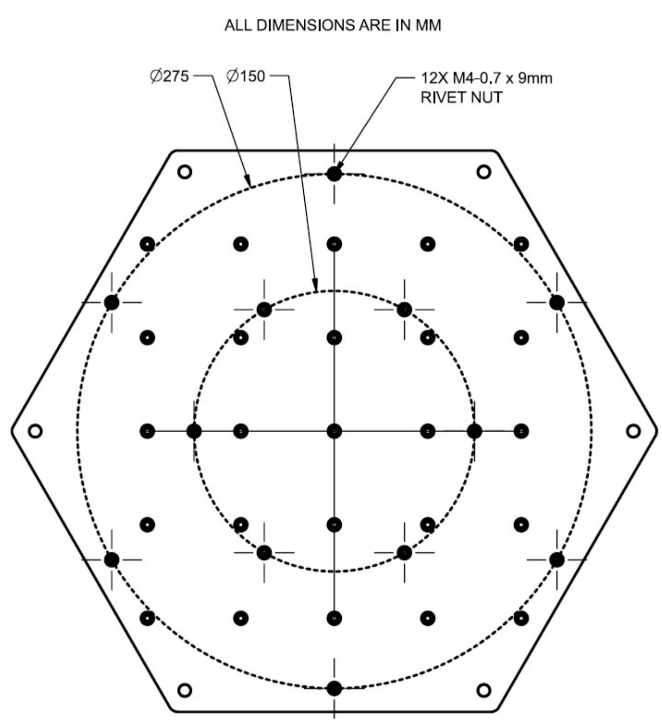


FIGURE A5-6 – CSA INTERFACE PLATE 1 – CIRCULAR BOLT PATTERNS

A.1.2 CSA Interface Plate 2 –Nadir View

The second CSA interface plate has a central view port that would enable the payload to have a nadir view. Its mass, including the rivet nuts, is 260g.

This interface has two different hole patterns for payloads to use: one rectangular and one circular. Both patterns are centered on the center of the plate. The rectangular hole pattern is a square pattern with 5 holes on each edge. Adjacent holes have a spacing of 50mm, giving the square dimensions of 250mm x 250mm. The circular hole pattern contains 6 holes evenly spaced on a circle of diameter 275mm. Note that the 275mm pattern is offset by 30° from the rod clearance hole pattern.

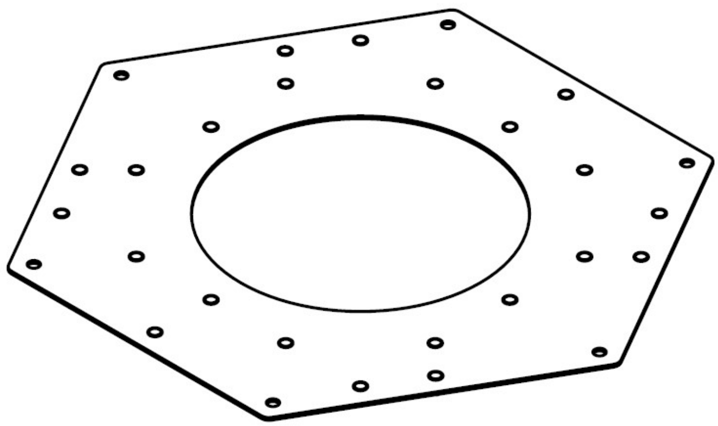


FIGURE A5-7 – CSA INTERFACE PLATE 2 – ISOMETRIC VIEW

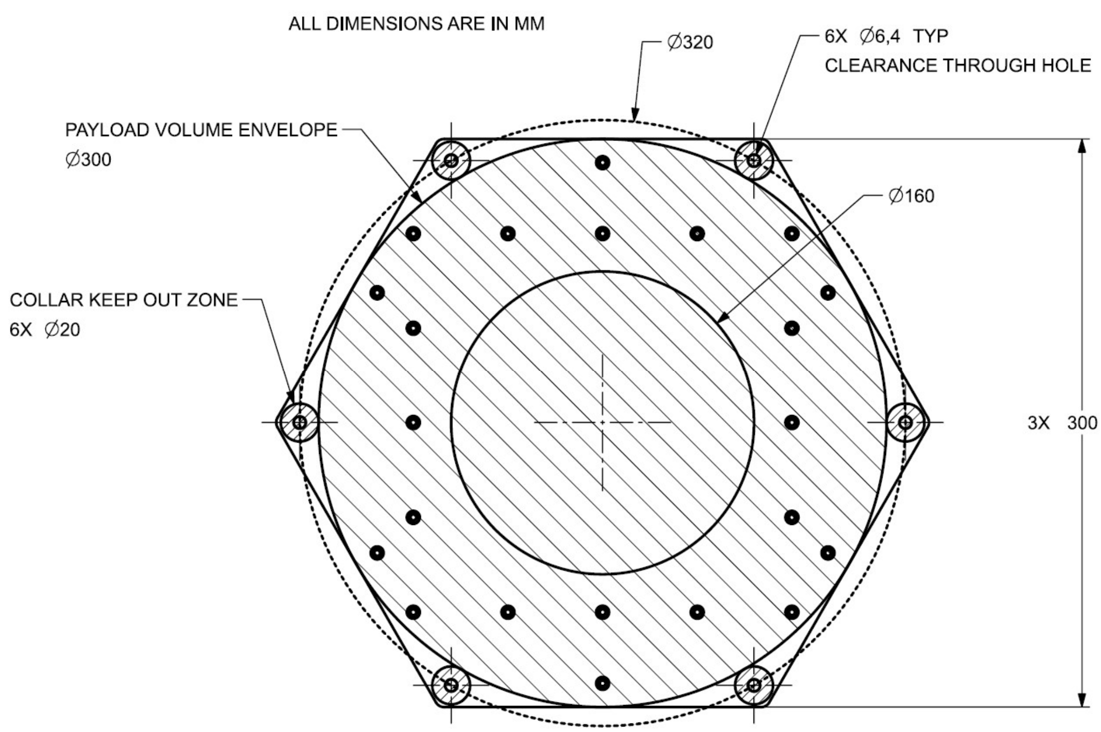


FIGURE A5-8 – CSA INTERFACE PLATE 2 – PAYLOAD VOLUME ENVELOPE AND COLLAR KEEP OUT ZONES

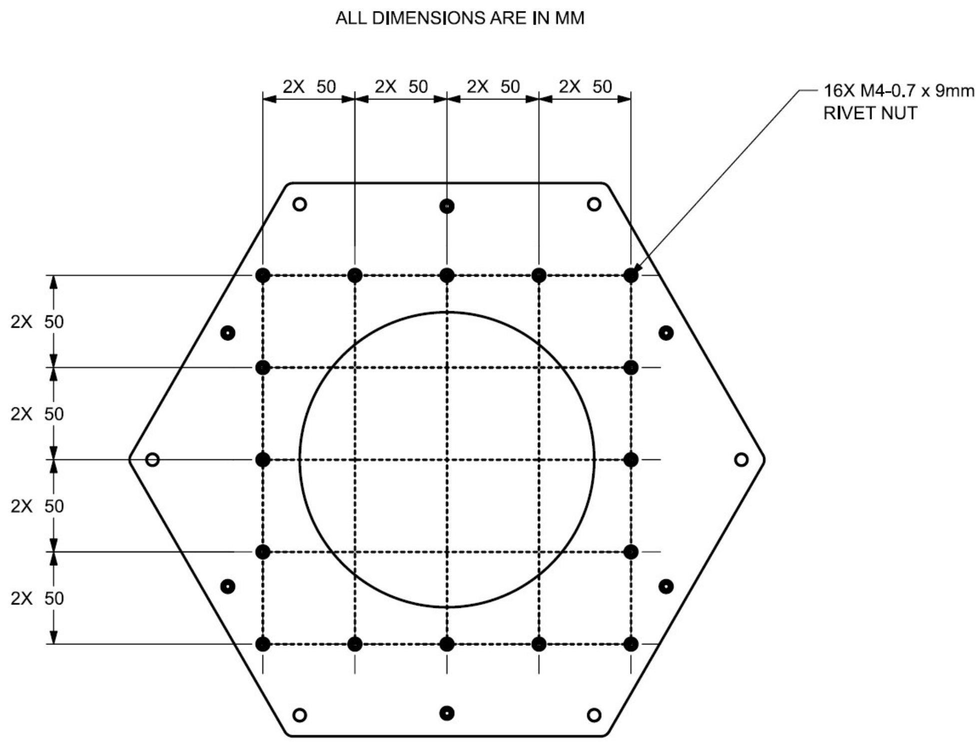


FIGURE A5-9 – CSA INTERFACE PLATE 2 – RECTANGULAR BOLT PATTERN

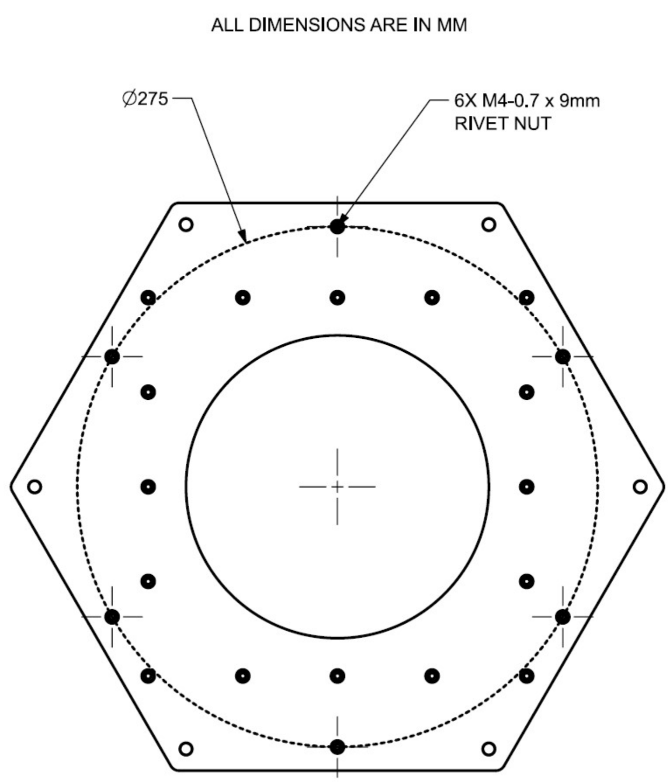


FIGURE A5-10 – CSA INTERFACE PLATE 2 – CIRCULAR BOLT PATTERN

A.2 PAYLOAD CUSTOM INTERFACE PLATES

Payloads may also choose to design and provide their own custom interface plates. The interface plate is not restricted to the payload volume envelope, but has other restrictions. The mass of this interface plate must be included in the payload's total mass, and the plate must:

- Not be more than 10mm in thickness;
- Have a flat bottom face;
- Have 6 clearance holes of diameter 6.4mm, positioned according to Figure A5-11, with at least 7.5mm of material surrounding each hole;
- Not go beyond the hexagonal boundary shown in Figure A5-11;
- And have a minimum corner radius of 5mm.

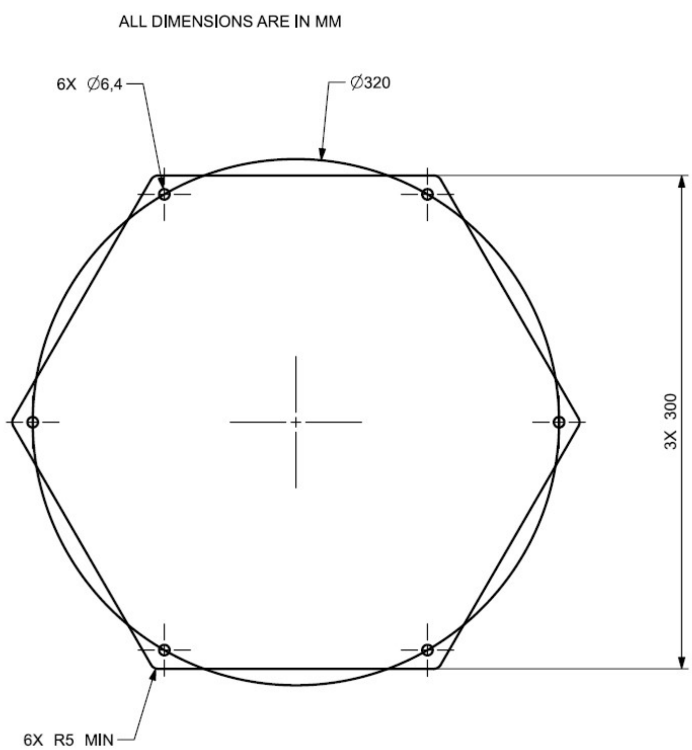


FIGURE A5-11 – CUSTOM INTERFACE PLATE SCHEMATIC

APPENDIX B MECHANICAL ICD – DISTRIBUTED CONFIGURATION

In the Distributed Configuration, the payload sits below the avionics gondola in the flight train, thus, it is physically attached from above. The avionics gondola offers two attachment points (both of which must be used) for the payload to connect to.

Further info TBD

APPENDIX C ELECTRICAL ICD

Info TBD