0.0 APPROVALS AND TRACKING

0.1. Signatures

Prepared by: ___________________________ 10-10-2012
Emily Logan, COSGC Date
RockSat Student Project Manager

Reviewed by: ___________________________ 10-10-2012
Chris Koehler, COSGC Date
COSGC Boulder Director

Concurrence: ___________________________ 10-10-2012
Giovanni Rosanova, Wallops Flight Facility Date
Payload Systems Manager
Sounding Rockets Program Office
## 0.2. Revisions

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<th>Description</th>
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<td>DRAFT</td>
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<td>1</td>
<td>Power section updated to reflect command line and RockOn requirements. References to Shawn Carroll and 2010 dates highlighted or changed to reflect changes for 2011.</td>
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<td>2</td>
<td>Updated for 2010-2011 program, including dates, electrical requirements, images, appendices, and addition of Visual Inspection Procedure</td>
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<td>3</td>
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<td>9</td>
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<td>6/29/17</td>
<td>LJH</td>
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<tr>
<td>10</td>
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<td>11</td>
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<td>7/23/19</td>
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1.0 INTRODUCTION

1.1. RockSat Program

RockSat-C is a follow-up program to the RockOn Workshop where customers design their own sounding rocket payload and compete for a spot on the launch vehicle. The RockOn Workshop teaches participants how to build a sounding rocket payload in three days. The goal is that participants will take what they learn during the workshop and return the next year with an original payload to fly with RockSat-C or RockSat-X programs.

The RockSat-C program is designed to provide students with access to low-cost flight opportunities and further develop their engineering skills. The RockSat-C flight is made possible through significant cost sharing provided by Wallops Flight Facility (WFF) and the program fees paid by RockSat-C teams. A portion of the RockSat-C program fees are invested back into the RockOn Workshop. The RockSat-C and RockOn Workshop canisters fly on the same rocket each year.

The program uses a modular canister system to allow for simple integration to the WFF Sub-SEM ring assembly. This standardized approach simplifies final integration and allows for more focus on the design of the payload. The organizers of the RockSat-C program guide the RockSat-C customers through the design process in the fall with multiple design reviews, leading projects to a Critical Design Review level design in December. Based on available space in the rocket, the most developed and capable projects are selected for flight in January. These projects then make their first payment and begin building. The projects continue to have subsystem and system testing reviews with the RockSat-C program manager through May. Any special requirements that arise for payloads are communicated to WFF through the RockSat program manager. The program culminates in June when the teams travel to WFF in Virginia for inspection, integration to the rocket, launch and recovery.

1.2. Participant Eligibility and Responsibility

The intent of the RockSat-C program is to provide hands-on experiences to students and faculty advisors to better equip them for supporting the future technical workforce needs of the United States and/or helping those students and faculty advisors become principal investigators on future NASA science missions. Therefore, RockSat-C is limited to U.S. educational institutions; only payloads from U.S. educational institutions are eligible to participate in the RockSat-C program. For the purpose of RockSat-C, ‘educational institution’ is defined broadly and includes, but is not limited to, the following: universities, colleges, technical schools, public and private high school, middle school and grade school, science museums, etc. Organizations which are not included in the above listing, are encouraged to contact Colorado Space Grant Consortium (COSGC) to clarify their eligibility in the program. In addition, U.S. entities (e.g. industry, research institutions, etc.) that fall outside of the eligibility conditions listed above, but that are interested in participating in the program, are encouraged to team with an eligible U.S. educational institution. Teaming between educational institutions and industry or other interests is allowed and encouraged.
Participation in the RockSat-C program includes teleconferences with WFF employees and contractors. All integration, testing, launch, and recovery operations take place at WFF. Normal access to WFF facilities and personnel is limited to U.S. persons only, therefore individuals participating in the RockSat-C program must be a U.S. Person. U.S. federal law defines a U.S. Person as: a citizen of the United States, an alien lawfully admitted for permanent residence, or a corporation that is incorporated in the U.S. (22 CFR 120.14, 15 – and by 8 U.S.C. 1101(a)(20)). Additionally, participants in the RockSat-C program shall comply with export regulations in regards to disclosures of technical data. All participants warrant and represent that they will limit disclosure of any technical data contained in, made available, or generated in the performance of their participation in the RockSat-C program in accordance with export restrictions imposed by the U.S. Export Administration Regulations, 15 C.F.R. Parts 768 et seq. and the International Traffic in Arms Regulation, 22 C.F. R. Part 120 et seq. This applies to all parties involved (such as an industrial partner to an educational institution).

1.3. Purpose

The purpose of this document is to identify the interfaces, requirements and logistics pertaining to the University of Colorado at Boulder (CU-Boulder) Colorado Space Grant Consortium’s (COSGC) RockSat Payload Canister Program. This document also establishes the guidelines and requirements for qualifying a payload for selection to be flown in June, along with the review and integration schedule. Payloads shall be student based with faculty and/or industry involvement only. The RockSat-C flight opportunity is not available to payloads that are profit-related endeavors and/or industry research and development. Students must be actively engaged and involved.

1.4. Getting Involved (Intent to Fly Form—IFF)

Interested institutions will need to submit an Intent to Fly Form (IFF) no later than September 16, 2019 at 5:00 PM MDT. No later than October 11, 2019, each initially selected institution will make a $1,000 earnest deposit. This deposit is fully refundable until the customer has been down selected as a finalist in the month of January. Further details on the selection process can be found in Section 8.

1.5. Canister Space

Customers have a choice of whether to use an entire canister or half of a canister. Those that wish to share a RockSat-C Payload Canister shall indicate this on the submitted Intent to Fly Form (IFF). Sharing a canister indicates that the customer will use one-half of the usable space and one-half of the allowed mass. Customers may use an entire can or half of a can, as long as their payloads still meet the weight and center of gravity requirements.

Customers are encouraged to collaborate and pair prior to the submittal of the Intent to Fly Form. In the event that shared customers cannot fill a canister, COSGC will pair the remaining customers to fill each canister. Initial customer pairings shall be released after Preliminary Design Reviews (PDR). Final customer pairings shall be released with the final downselect. It is each customer’s responsibility to review the list and request changes in pairing assignments within two weeks of notification of initial pairing, if desired.
Upon final selections, all pairings, mass allotments, and volume allotments are final and cannot be changed without written consent of COSGC. In the event that a subset of customers would like to redistribute allotments, all customers of the subset must contact COSGC, and changes will only be made with written approval of all parties involved and COSGC. Cost sharing is covered in Section 1.6.

In shared canisters, one customer will mount to the bottom plate of the canister and the other will mount to the top plate. The customer hardware will not interface with each other, only to the canister. However, customers sharing a canister should be in contact to make sure integration will go smoothly with both payloads meeting the structural and electrical requirements outlined in this document. A mid-mounting plate is available on request to COSGC to provide separation between payloads or a mount for a camera utilizing an optical port.

1.6. Cost

The cost of the RockSat-C flight opportunity is contingent upon the fraction of the canister being utilized. This cost covers the following expenses: launch costs, one (1) RockSat-C payload canister, mission management support, and other amenities supplied during the week of launch.

During the week of launch, the cost will also provide the following amenities for four team members: lunch on the first Friday integration (June 19th), breakfast and lunch on the following Monday through Wednesday (22nd – 24th), a hot breakfast the day of launch (June 25th), lunch on launch day, and a final celebration dinner on the evening of launch. Additionally, each of the four members will receive a RockSat-C t-shirt. The cost will NOT cover travel to and from Wallops Flight Facility, lodging, or other expenses incurred. In the event that a team would like to bring more than four team members, additional meals and t-shirts can be purchased in advance. Additional details will be provided closer to launch for those wishing to send more than four participants. Please notify Audrey or Chris as soon as possible if extra shirts and/or meals are required.

A table summarizing the cost of participation in the RockSat-C program is shown in Table 1. *These costs include the earnest deposit of $1,000.*

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<td><strong>Fraction</strong></td>
<td><strong>Cost</strong></td>
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1.6.1. Dedicated Customers

A dedicated customer is an institution whose payload will occupy an entire canister. If a dedicated customer’s payload is chosen to fly at final down select (January), he/she will then make two additional equal payments of $5,500 on 02/10/2020 and 04/10/2020. *After receipt of*
the first installment of $5,500, each customer will be sent one RockSat-C payload canister contingent upon machining completion, and all deposits/payments shall become non-refundable. All payments must be made in the form of a check made payable to: University of Colorado. Payments should be sent to:

Colorado Space Grant Consortium  
Discovery Learning Center Room 270  
520 UCB  
Boulder, Colorado 80309-0520

1.6.2. Share Customers

A share customer is an institution whose payload will occupy only a fraction of a canister. Share customers only have the option to occupy one-half of a canister; no other fractions will be allowed due to the added complexity of pairing. The assigned fraction sets the maximum volume and mass that the shared customer can occupy from the available mass and volume. How each shared customer occupies his/her territory is the business of the sharing customers in the specific canister. Table 1 (above) summarizes the total cost for each shared customer payload.

At the time that earnest deposits are due, all share customers shall still pay the earnest deposit of $1,000 made payable in the same method as described in Section 1.6.1. After receipt of the first installment (February), all deposits shall become non-refundable. In the event that a subset of sharing customers is chosen at final down select, the remaining cost to each customer in the canister will be broken into two equal payments of $3,000. These payments will be made on the dates indicated in the schedule (02/10/2020 and 04/10/2020) (see Section 9.0). The RockSat-C payload canister for a sharing subset will be given to the customers on the night of arrival in Virginia for fit checks.

1.7. Points of Contact

Program points of contact (POC’s) are as follows:

| Colorado Space Grant Director | Chris Koehler  
| | 303-492-4750  
| | koehler@colorado.edu  
| Colorado Space Grant RockSat-C Student Program Manager | Audrey Viland  
| | 719-433-4291  
| | rocksatprogram@gmail.com  

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1.8. Applicable Documents and Links

- Colorado Space Grant Consortium RockSat website: http://spacegrant.colorado.edu/national-programs/rs-c-2020-home
- Colorado Space Grant Consortium RockOn Workshop website: http://spacegrant.colorado.edu/rockon
- NASA Wallops Flight Facility: http://www.nasa.gov/centers/wallops/home/index.html

2.0 ROCKSAT OVERVIEW

The RockSat payload canister is a modular system of canisters designed for suborbital flights with Wallops Flight Facility’s (WFF) Sub-SEM ring assembly (Figures 4 and 5). Images and solid models are also given below in Figures 1-3, 6, and Appendix A. The objective of the RockSat-C payload canister is to give customers a design envelope to build around that will allow easy integration to any WFF rocket using the Sub-SEM ring assembly. This standardized approach provides customers low-cost access to space. The RockSat-C payload canister was successfully tested in June of 2008 through the RockOn Workshop when five RockSat-C payload canisters carried payloads to an altitude of greater than 40 miles on WFF’s improved Orion rocket.

The second iteration of the RockOn Workshop took place June 21-26, 2009. The first iteration of RockSat-C flew with the workshop on June 26, 2009 when four customer cans carrying ten experiments soared to an altitude of greater than 72 miles (117 km) on Wallops Flight Facility Terrier-Improved Orion rocket.

The third RockOn Workshop was held June 19-24, 2010, and the second set of RockSat-C experiments was launched on June 24, 2010. Five customer cans containing experiments from ten universities reached an altitude of 72.7 miles (117 km) on a WFF Terrier-Improved Orion rocket.

RockOn 2011, held June 18th-23rd 2011, had teams from multiple universities for a total of 27 participants. The RockSat-C 2011 program had nine teams from 8 schools to fill a total of seven canisters on the Terrier-Improved Orion launch vehicle. A total of 45 students and faculty mentors came to Virginia to support their payload’s launch. The flight reached 74.3 miles (119.6 km) and was once again successfully recovered.

In 2012, RockOn and RockSat-C had close to 100 participants, with 43 participants attending the workshop. Ten university teams attended to support their RockSat-C payloads. The workshop was held June 16th-21st, with another successful launch carrying the payloads to over 100 km. This year was also the first year in which RockOn Workshop payloads were combined in a canister with a RockSat-C university payload. This collaboration was very successful. In the event that a selected RockSat-C payload canister cannot fly on launch day, there shall be back up mass simulators present and ready to fill the vacant spot.
The sixth iteration of RockOn occurred in 2013 with 49 participants filling three canisters. Nine RocketSat-C teams in five canisters traveled to the integration and launch, which occurred on June 20th. The Improved Terrier-Orion rocket launched to 74 miles and was successfully recovered.

RockOn 2014 had a record breaking 62 participants attend the workshop, and in all 110 people took part in the integration and launch activities at Wallops for the RockSat-C and RockOn Programs. Six institutions flew five canister and one half payload that integrated with a half payload from the RockOn workshop. Three full canisters, one half canister, and four lid-mounted payloads allowed a total of 21 RockOn payloads to fly. The flight flew 73 miles on June 26th and was successfully recovered.

RockOn 2015 had an even more record breaking 72 participants in the workshop, with approximately 140 people attending the integration and launch activities at Wallops across the RockSat-C and RockOn Programs. RockSat-C had 11 participating institutions filling 6 full canisters that integrated with 3 RockOn canisters and 4 RockOn payloads mounted on the lids of canisters. On June 25th at 6:00am sharp, the payload launched and flew to a 71 mile apogee before splashing in the ocean, ending a successfully recovery.

RockOn 2016 experienced a number of firsts with 68 participants in the workshop and approximately 160 people attending the integration and launch activities at Wallops in both the RockSat-C and RockOn programs. RockSat-C had 9 participating institutions filling 5½ canisters that integrated with 3½ RockOn canisters (3 more payloads than ever flown before) and 4 RockOn payloads mounted on the lids of the canisters. For the first time ever, launch was scrubbed due to poor weather conditions and a bad sea state. It was rescheduled for June 24, and a couple of minutes after 6:00am, the rocket was launched and reached an apogee of 74 miles before splashing in the ocean and were successfully recovered.

RockOn/RockSat-C 2017 was successfully launched on June 22, 2017 at 5:30am. This marked the 10th anniversary for RockOn, and the launch activities included a special recognition ceremony for all those who had supported the program. The rocket reached an apogee of 74 miles before landing in the ocean and was successfully recovered. There were 67 RockOn participants who integrated into 4 canisters with 4 lid payloads. RockSat-C had 8 participating institutions which integrated into 5 canisters. This mission also flew, for the first time, four powered elementary/middle school student experiments inside one of the RockOn canisters.

RockOn 2018 experienced the most workshop participants yet with 95 participants and 28 teams. This was the first year a new mechanical design was tested and allowed for eight teams to fly per canister. The RockOn canisters occupied 3 ½ spaces in the rocket while RockSat-C filled the remaining 5 ½ canisters with Cubes in Space in the nose cone. Overall, RockSat-C had nine institutions flying experiments in the rocket and reached an apogee of 75 miles before being successfully recovered.

RockOn/RockSat-C 2019 successfully launched on June 20, 2019 at 5:30 am. This marked the 12th year for RockOn and the 11th year for RockSat-C. The RockOn canisters occupied 3 ½ spaces in the aft section while RockSat-C contained the remaining 5 ½ with Cubes in Space.
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flying in the nose cone. RockSat-C had nine institutions flying experiments and RockOn had 28 teams, once again proving the space in F3 can comfortably hold over 100 people. The rocket reached an apogee of 73 miles before being quickly and successfully recovered.

2.1. RockSat Payload Canister Images

![Figure 1: RockSat Payload Canister](image1)

![Figure 2: RockSat Payload Canister](image2)

![Figure 3: RockSat Payload Canister](image3)

** Makrolon plates visible in the picture and SolidWorks model are part of the RockOn workshop and ** ** are not required or included. **

3.0 ROCKET DESCRIPTION AND CAPABILITIES

This section covers key interfacing and launch vehicle capabilities that customers should be aware of for the design of his/her payload.

3.1. RockSat Payload Canister Interface General Description

Each RockSat payload canister will be attached to the Sub-SEM ring assembly in a stacked configuration (Figure 4). The Sub-SEM rings are further attached to longerons that span the entire length of the experiment section (Figures 4 and 5). With 9 RockSat canisters flying (3
RockSat Payload Canister User’s Guide

RockOn, 6 RockSat-C customers), the Terrier-Orion is estimated to reach an altitude of approximately 68-72 miles (110-120 km).

The selected RockSat-C payload canisters will be flying with three to three and a half (3 – 3½) other RockSat payload canisters that will contain payloads of RockOn 2020 workshop participants. The RockSat-C payload canisters shall use the five (5) top bulkhead bolts and five (5) bottom bulkhead bolts to secure the payload to both the canister lid and base. Further details on these bolts and dimensions are discussed in Section 5.2.

In addition to meeting the bolt interface requirements, each payload shall conform to the activation requirements set forth in Section 5.2.2. A compliance test shall be performed before integration. **Payloads that do not meet these requirements shall be removed from the flight.** The payload activation system shall be designed such that the wires pass through the designated wire-way. Further details on the dimensions and location of the wire-way can be viewed in Section 5.1.5 and Appendix A.

The RockSat payload canister is cylindrical in shape. The useable payload space has a diameter of approximately 9.3 inches and an approximate height of 9.5 inches; see Figure 6 and mechanical drawings in Appendix A for exact dimensions. Each RockSat payload canister weighs approximately 6.7 pounds without caphead screws. A mid-mount plate (1.5 lbs) is also available to provide separation for shared canister, if desired by the customers. The total weight of the integrated RockSat-C payload canister, complete with customer hardware, shall be 20±0.2 lbf. No modifications shall be made to the RockSat payload canister. **Violation of this rule will result in the customer being removed from the flight.**
3.1.1. Modular Structure, Sub-SEM, and Payload Space Images

Figure 4: Modular Stacked Assembly  Figure 4: Longerons and Sub-SEM Ring

RBF connections to Terrier-Orion shorting plug run down the side of the cans and through the inner diameter of the sub-SEM ring assembly.

Figure 5: RockSat Payload Canister Volume Constraints

3.2. Rocket Key Performance Parameters
### Table 2: Key Performance Parameters

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<tr>
<td>Spin Rate (Hz)</td>
<td>≈1.3 Hz at Terrier burn out;</td>
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</tr>
<tr>
<td></td>
<td>≈5.6 Hz at Orion burn out</td>
<td>1,2</td>
</tr>
<tr>
<td>Maximum Ascent G-Load</td>
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</tr>
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<td>1,2</td>
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<td>Chute Deploy (seconds)</td>
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<td>1,2</td>
</tr>
<tr>
<td>Splash Down (seconds)</td>
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<td>1,2</td>
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</table>

**Notes:**

1. All parameters are subject to change, but all customers will be notified of any changes.
2. Data from 2009 Terrier Improved Orion launch.

### 3.3. Flight Environment Conditions

The biggest environmental factor to consider for WFF flights will be G-loading. During the 2008 RockOn workshop, participants recorded sustained G-loads of approximately 25 Gs during ascent on the improved Orion rocket. Payloads shall be designed to withstand 25 Gs of quasi-static loading in all three axes with possible impulses of approximately 50 Gs in the Z (longitudinal) axis. Three-axis vibration testing will be conducted by WFF before flight. **Payloads that do not pass the vibration test will be removed from the flight at WFF’s discretion.**

Temperatures in the experiment section began at ambient (72° F for RockOn 2008), and climbed to a maximum of 90° F during the ascent of the improved Orion.

In most orbital and suborbital flights, outgassing is an important consideration. Wallops Flight Facility pressurizes its experiment sections with oxygen-less air, so this should not be an issue. In the event that the seal is lost, it is best to use low outgassing materials in payload design. Outgassing properties for most materials can be found at: [http://outgassing.nasa.gov/](http://outgassing.nasa.gov/).

### 3.4. Disclaimer

Recovery of payloads is not guaranteed. As with any flight, there are possible anomalies that can occur during the flight or recovery that can severely damage or destroy flight hardware. All selected teams should consider this and understand that space flight involves risks that neither COSGC nor WFF can plan for. Selected payloads assume all risks, and neither of the said institutions shall be held responsible in event of an anomaly and/or unrecoverable payload.

### 4.0 ORGANIZATIONAL RESPONSIBILITIES

#### 4.1. Hardware and Interface Responsibilities

Component and functional design responsibilities are listed below.
RockSat-C Payload Customer

- Payload experiment and support system
  - Support system includes:
    - Power to operate payload
    - Data storage
    - Thermal system (if desired)
    - Internal structure to RockSat payload canister
    - All environmental sensors (if desired)
    - Activation system at launch (in accordance with Section 5.2.2.)
- Mechanical interface and bolts to the ten (10) bulk head screws outlined in Section 5.2.1.
- Safety features for experiment-related hazards
- Teflon insulated activation wires of at least 3 feet exiting the canister for each payload (wires must be >24 AWG i.e. thinner rather than thicker).
- All required ground side data analysis equipment (computers not provided)
- Required interfacing between sharing customers

COSGC and WFF

- Terrier-Orion rocket, range safety, launch support, recovery and tracking
- One (1) RockSat payload canister
- Sixteen (16) 8-32 Black Oxide Alloy Steel Socket Head Cap Screws (for canister side screws) (bulk heads not provided)
- Pressure and vibration testing and integration onto rocket

4.2. Ground Control

After the RockSat-C payload canisters have been integrated onto the sub-SEM ring assembly three days prior to launch, the customer will have very limited access to the payload, if any. WFF will handle all activities pertaining to payload preparation, launch, and recovery. Customers will not have access to the payload after integration until the rocket has been recovered and the payload section is de-integrated.

5.0 PAYLOAD DESIGN REQUIREMENTS

5.1. Payload Physical Envelope, Mass, and Center of Gravity Requirements

The following subsections outline the physical requirements and constraints of the RockSat-C payload canister.

5.1.1. Constraints on Payload Types

The purpose or mission of a payload is open to the customer. The customer shall design a payload that by all standards (engineering and laymen) would be considered safe and practical. Experiments shall not put other payloads, WFF employees, COSGC employees, or the launch vehicle at risk. All payloads shall be formally selected before the customer can become a contender for flight. This approval will come with signatures on the Intent to Fly Form (IFF) that shall be submitted no later than September 16, 2019 at 5:00 PM MDT. The RockSat-C
payload canister can be sub-divided between two customers to share space and costs. If two customers choose to share payload space, this should be documented on the IFF.

5.1.2. Physical Envelope
All payloads must be contained within the RockSat-C payload canister. The canister is cylindrical in shape with a diameter of 9.3 inches and a height of 9.5 inches. The payload may occupy as much or as little of this space as desired as long as it meets the requirements outlined in the following section. Mechanical drawings of the RockSat payload canister are contained in Appendix A.

5.1.3. Mass Properties
The entire RockSat payload canister and payload shall weigh within 20±0.2 lbf (9.07 kg). Experiments with hardware weighing less than this 20±0.2 lbf requirement are expected to incorporate well-secured ballast to meet this weight envelope. RockSat-C payload canister will be weighed prior to integration. This weight will not include the mass of the multipurpose port and contents nor NPT/tubing. Cans not conforming to the weight constraints will be removed from the flight.

5.1.4. Center of Gravity
All payloads shall be designed to have a center of gravity (CG) that lies within a 1 x 1 x 1 inch envelope of the geometric centroid of the integrated RockSat-C payload canister. To ensure stable flight, WFF may require a moment of inertia (MOI) test prior launch. This test will confirm that the CG of the payload and RockSat payload canister lie within the one inch cube envelope discussed above. Payloads that do not meet WFF’s CG requirements will be removed from the flight.

5.1.5. Payload Access Openings and Wire-Way
The RockSat-C payload canister has two (2) payload access openings that are separated by 180 degrees. These openings have approximate dimensions of 3.5 inches wide by 4.5 inches tall. The wire-way is offset 90 degrees from these windows. The wire-way consists of a notch on the bottom and top bulkheads that allow the Remove Before Flight (RBF) and other necessary wires to pass down the payload section. In addition to the notches, the RockSat-C payload canister skin has a cut-away for running wires. Mechanical drawings of the locations and dimensions of the windows and wire-way can be found in Appendix A.

COSGC and WFF require that each RockSat-C payload canister pass down one (1) set of two (2) wires that WFF personnel will connect to the launch vehicle shorting plug and/or relay (see Section 5.2.2 for more information on electrical interfaces). Each experiment shall have one (1) set of RBF wires of no shorter than 3 feet and 24-gauge maximum thickness wire. These wires will be trimmed and will have Winchester connectors added at WFF. If you need thicker wire, it must be approved by Audrey or Chris no later than the CDR. Current passing through these wires must comply with the requirements outlined in Section 5.2.2.1, Payload Activation. If other wires need to be passed to other payloads or to WFF, a formal variance request should be submitted to Chris Koehler and Audrey Viland.
5.1.6. Environmental Access Ports

Unless indicated otherwise on the IFF, all payloads are assumed to be contained within the experiment section and will not have access to an environmental access port (i.e. optical or atmospheric). If a port is desired, this needs to be explicitly stated on the IFF. Not all payloads can be granted access to these ports due to limitations of the rocket skin.

For the RockSat-C flight, the customer payload section will have access to two static pressure ports, two dynamic pressure ports, and seven total optical or multipurpose ports (with a maximum of 4 optical ports). As stated above, not all payloads can be granted access to these ports, and any desired ports shall be indicated in the IFF. Additionally, only dedicated customers can be guaranteed access to more than one port (multipurpose or environmental). Shared customers may request multiple ports, but it is not guaranteed that both requests will be accommodated. When choosing sharing partners, it should be noted that only one optical port can be provided per canister. The optical ports have a diameter of 1.5 inches and are made of quartz.

If a customer is granted access to an atmospheric port, he/she must provide the drop down tubing to interface to WFF. The customer end shall terminate with a male ¼” NPT connector. Tube lengths shall be at least 3 feet long. All customers shall use PFA tubing and tube fittings from Swagelok for all connections between port and payload. More details are included in Appendix B. In addition to providing the drop down tubing, customers using an atmospheric port shall also design a redundant valve to close prior to splash down to ensure that no water will enter the payload section in the event of a WFF shut off valve failure. WFF valves are designed to open at 5,000 feet on ascent and close at 5,000 feet during descent.

5.1.7. Multipurpose Ports

Beginning on the RockSat-C 2016 launch, a new type or port – known as a multipurpose port – was utilized in order to standardize access to space. These ports were designed to accommodate numerous types of scientific hardware and include a simple method for integration with the payload.

The port pocket is the part that holds the customer’s hardware. The hardware space is approximately a 2.5”x2.5” square with an approximate depth of 1.4” (depending on location in the pocket). The hardware within the pocket is secured using four screws attached to the lower level holes (the upper level holes are used to secure the cover). Two types of connection are available depending on the customer’s needs: 9-pin and dual SMA. The hardware within the port will connect internally to the connector and a separate wire (provided by the customer) will connect the port externally to the payload. The pocket also has an optional, modifiable cover. Figures 7 and 8 show the completed multipurpose port including the cover.
If a customer is granted access to a multipurpose port, he/she **must provide the appropriate connection between the port and his/her payload (ie. 9-pin or dual SMA)**. If you are looking into using SMA connectors, please research how to properly attach your wires to the SMA connectors (i.e. proper crimping tools, method, etc). Although the cover may be modified, it shall not extend past the rocket skin, and no hardware shall extend past or wrap around the skin without prior consent from Audrey Viland and Chris Koehler. Nothing can be permanently attached to the port pocket although they can be attached to the door. Additionally, the hardware must be isolated from the pocket (i.e. there is no voltage on the pocket). More details on how the ports interface with the rocket skin and additional drawings are included in Appendix C.

### 5.1.8. Summary of Key Constraints

**Table 3: Summary of Key Constraints**

<table>
<thead>
<tr>
<th>Type</th>
<th>Quantitative Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Envelope</td>
<td>Cylindrical:</td>
</tr>
<tr>
<td></td>
<td>Diameter: 9.3 inches</td>
</tr>
<tr>
<td></td>
<td>Height: 9.5 inches</td>
</tr>
<tr>
<td>Mass</td>
<td>Canister + Payload = 20±0.2 lbf</td>
</tr>
<tr>
<td>Center of Gravity</td>
<td>Lies within a 1x1x1 inch envelope of the RockSat payload canister’s geometric centroid.</td>
</tr>
<tr>
<td>Ports – optical, multipurpose, or</td>
<td>Customer shall provide drop down tubing for atmospheric plumbing. Plumbing must</td>
</tr>
<tr>
<td>atmospheric</td>
<td>terminate with a male ¼” NPT connector. Additionally, the customer shall design in</td>
</tr>
<tr>
<td></td>
<td>a redundant valve to protect the payload at splash down. Customer shall provide</td>
</tr>
<tr>
<td></td>
<td>appropriate connection between port and payload (dual SMA or 9-pin). Additionally,</td>
</tr>
<tr>
<td></td>
<td>customer shall not permanently attach</td>
</tr>
</tbody>
</table>
5.2. Payload Interfaces

The main interfaces the customer must consider to integrate to the launch vehicle are mechanical and electrical. The following sections discuss the requirements for each interface type.

5.2.1. Mechanical Interfaces

The payload shall be contained within the RockSat-C payload canister. The restrictions on volume, mass, and CG can be found above in Section 5.1. In addition to the above restrictions, each payload shall be designed such that its internal structure mounts to both the top and bottom bulkheads of the RockSat payload canister. The top and bottom bulkheads each have holes for five (5) 8-32 black oxide alloy steel socket head cap screws. The customer’s payload must mount to at least eight of the ten (10) said bolts. The bolt head shall be on the outside of the canister going into the payload. This requirement will ensure that the top and bottom bulkheads are secured to the payload.

No payload may alter or modify the RockSat-C payload canister in any way. The RockSat-C payload canister shall remain in the same state that it was issued in, and no part of the internal payload shall be mounted to any other part of the RockSat-C payload canister except the bulkheads as described above. RockSat-C canisters remain the property of COSGC and WFF after flight and recovery and must be returned to COSGC.

Shared canisters have the option to use a mid-mounting plate to provide separation between customers. The mid-mounting plate, if requested, will be provided to the customer by COSGC with the canister. Customers may also alter the mid-mounting plates for hardware mounting if desired, but all alteration requests must be approved by COSGC prior to any alterations. Mid-mounting plate request must be submitted to Audrey Viland or Chris Koehler prior to the Critical Design Review (CDR).

5.2.2. Electrical Interfaces

Each payload shall be electrically self-contained. No power will be provided by WFF or the launch vehicle. It is highly recommended that all payloads use rechargeable batteries. Customers may use rechargeable lithium batteries, but rechargeable lithium ion batteries may not be recharged while payload is at WFF. Other types of rechargeable batteries may be used and recharged at WFF, such as NiMH. Non-rechargeable lithium ions are allowed. It is recommended that all payloads have their batteries approved by COSGC before purchasing them. Coin cell batteries or other batteries that may allow power during arming are not allowed on the rocket due to safety concerns for WFF employees.

In addition to providing power, the customer must ensure that the payload is completely isolated from the canister. Their payload electronics must not be shorted or connected to the canister in any way. More information about this requirement can be found in Section 5.2.2.2.
The customer must provide at least one (1) set of two (2) wires for payload activation, conforming to the requirements outlined in Section 5.2.2.1 below. These wires must be **Teflon insulated** to ease the RockSat-C/WFF interfacing. Customers must also provide one (1) wire connected to the payload ground, for use in confirming isolation from the canister during the Check-In procedure prior to arriving at Wallops. These wires must be at or thinner than 24 AWG to allow the wire to successfully solder to the Winchester Connectors at Wallops Flight Facility. While the wires can be either solid or stranded, WFF recommends stranded for a better connection during soldering.

5.2.2.1. Payload Activation

Payload activation can occur in multiple ways. There are a total of approximately twenty-seven activation connectors for the six RockSat-C canisters. The electrical system contains nine (9) relays capable of providing connections for up to three (3) pairs of shorting wires. Each payload should strive to minimize the number of required activation lines and shall not exceed three (3). Payloads can choose how to activate, but for safety reasons all payloads must conform to either Requirement 1.SYS.1 or 1.SYS.2, whose parent is 0.SYS.1:

0.SYS.1 **All payloads shall be designed such that Wallops will always know its status as active or inactive (current flowing/not flowing).**

1.SYS.1 **Payloads wishing to activate early shall be designed such that Wallops can activate and deactivate the payload or subsections of the payload via a single set of shorting wires.**

1.SYS.2 **Payloads wishing to activate at launch shall be designed with two opens in the system such that activation occurs if and only if Wallops has shorted the connection and the G switch has been depressed.**

Typically, RockOn and RockSat-C payloads activate using the 1.SYS.2 configuration, with a g-switch. An example schematic is provided in the 1.SYS.2 section to demonstrate this activation scheme.

5.2.2.1.1. Requirement 1.SYS.1 – Early Activation

Requirement 0.SYS.1 is the parent requirement mandated by Wallops Flight Facility. Because each payload provides its own power, Wallops must be able to verify that current cannot flow anywhere in your payload during the arming procedure, which could result in prematurely igniting the rocket motor.

A payload designed to conform to 1.SYS.1 will activate/deactivate at Wallops’ command. This system is likened to a light switch, where Wallops can inhibit the flow of current via a relay. **This type of activation shall not latch**, meaning that when power is turned on, it can still be turned off. WFF must have full control of activating and deactivating the payload. A pictorial representation of this activation scheme is given in Figure 9. This activation is the simpler of the two options, but is reserved for teams that require an early activation. The diagram shows that the wires presented as the open can be the wires directly connected to the power on the payload.
Be advised that this system will be checked by COSGC and WFF to ensure compliance. This means that the payload will be powered on and off during inspection. Be sure to design the system so that any data collection occurring will be able to either reset or that there is enough memory space to account for the power-on during inspections. Any sensors that activate or deploy upon payload power on will also need to be retracted/de-activated upon payload power-down.

**Each set of wires conforming to 1.SYS.1 shall not exceed a peak current of 1000 mA**

![Diagram](image)

**Figure 9: 1.SYS.1 Activation Diagram**

The advantage of 1.SYS.1 is that Wallops can activate these payloads up to 10 minutes prior to launch. Customers may request an early activation time between T-10 minutes before launch to T-30 seconds before launch. However, if WFF chooses to hold the launch count down due to various reasons, it may be after the T-10 minute mark, but not past by the T-3 minute mark. *For this reason, it is strongly recommended that customers choose to activate at T-3 minutes or less.* Requests must be clearly communicated to Audrey Viland by the Critical Design Review (CDR).

Of the activation lines available, some of the lines will be designated to activate with a 1.SYS.1 activation type. This means that there are a limited number of early activation times that must be agreed upon by RockSat-C customers utilizing 1.SYS.1. The circuit provided by the relays will remain closed during the duration of the flight and well after landing.

5.2.2.1.2. Requirement 1.SYS.2 – G-switch Activation

Requirement 1.SYS.2 is based off of the RockOn activation system. The system shall be constructed such that there are two “opens” in the activation system before the shorting wires are closed, a WFF ARM connection and a G-switch. Once WFF closes the ARM connection via a relay, this will leave only one open in the system, the mechanically activated G-switch. No current shall flow through any portion of the payload until both opens have been closed at launch. The G-switch is internal to each payload and is not activated by WFF.
It is HIGHLY recommended that 1.SYS.2 payloads latch in a manner similar to the RockOn SHIELD board. Diagrams of an acceptable 1.SYS.2 activation system and the three key states are shown below.

Figure 10: Initial State of RBF System (Safe)

Figure 11: RBF System After WFF Shorting Plug Added (Armed)

Figure 12: RBF System After Launch (Activated)
Payloads utilizing an activation system conforming to 1.SYS.2 are proven and have worked well in previous missions. Unless the payload must activate early for calibration or other purposes, it is recommended that all payloads design to 1.SYS.2. Activation systems conforming to 1.SYS.2 will also be connected to one of the available relays. Payloads correctly designed to meet 1.SYS.2 should have the ability to connect to an early activating relay in the event that there are not enough designated RBF lines. This will not change the operation of the activation, since the system shall not activate until the mechanical g-switch is activated. The following figure is the RockOn g-switch activation, and can be used as an example when designing the 1.SYS.2 activation.

![Activation Schematic with G-Switch Implementation (RockOn Workshop Design)](image)

Note that the ARM LED must be excluded in the final design, as this is solely an indicator, and will cause an unpermitted current draw when the payload is off. It can simply be removed from the circuit, leaving the wire open.

5.2.2.2. Can Shorts and Voltage Checks

To ensure the safety of Wallops personnel, the potential of payload ground and all shorting wires will be measured relative to the RockSat-C Canister. The potential between the canister and all shorting/ground wires shall be 0 V and source no current. Otherwise, the customer will be removed from the flight at Wallops’ discretion. This DOES NOT mean the payload ground should be shorted to the canister to ensure 0V potential between them. The canister must be fully isolated from the payload. The customer must ensure that no power sources are shorted to the canister in any way (through heat-sinks, accidental battery shorts, mounting holes on circuit boards etc.). The procedure used to check this requirement is fully explained in the Visual Inspection Procedure (Appendix D) and must be checked prior to arriving at Wallops to ensure compliance.
5.2.2.3. High Voltage Requirements

WFF pressurizes the experiment sections on the rocket, but in the event that the seal is broken, the payloads will experience near vacuum conditions at apogee. To mitigate risk, no high voltage experiments (high voltage is defined as anything greater than 34V) will be allowed without a formal variance request. If a team would like to fly a Geiger Counter, we require the device to be conformal coated to reduce the risk of stray voltage. High voltage requests must also include a plan to prevent injury to personnel handling the experiment. This variance must be in written form and approved by Chris Koehler and Audrey Viland.

5.2.3. Telemetry Tracking and Control

Wallops Flight Facility will not provide real-time telemetry. Communication systems are prohibited; no payload shall transmit data of any kind, unless approval is sought through COSGC and approved by Wallops before the Mission Initiation Conference (MIC).

All data should be stored on on-board memory. Using on-board memory alleviates the complexity of a communication system, and has been proven to be extremely effective for the RockOn workshop and other COSGC rocket payloads.

Post flight radar tracking of the rocket will be made available. In the event that radar skin tracking data is provided from Wallops Flight Facility, COSGC will provide the data to teams that request a copy.

5.3. Structural Design Requirements

Each payload will experience extreme and varying G-loads during the course of flight. Workshop participants from RockOn 2008 experienced up to 25Gs in the positive Z (longitudinal) direction during ascent and experienced about +/- 10Gs in the X and Y (lateral) axes. In the event of a parachute failure, there would be more extreme loading in all three axes.

5.3.1. Material Selection

When designing the structure for the payload, materials with high resistance to stress corrosion cracking (SCC) are recommended. Materials that have worked well in the past have been aluminum (6061), steel, and Makrolon. Makrolon is used for all RockOn Workshop payload decks and has worked well for other COSGC rocket payloads. Plastics or other petroleum based materials shall be used sparingly. In the event of a pressure loss, outgassing could fog optics or sensors on other RockSat-C payloads.

5.4. Lasers and Liquids

Lasers will require possible training and completion of safety forms. Liquids will require accompanying MSDS sheets and possibly secondary containment. All use of these items will be contingent upon Wallops approval. Any requests to have these items shall be directed to Audrey Viland or Chris Koehler and approved before the Mission Initiation Conference (MIC).

5.5. Thermal Design Requirements

The customer is responsible for thermal control of his/her payload. Due to the short duration of the flight and the closed experiment section, thermal systems may not be required. The RockOn
workshop of 2008 saw an increase in temperature of 18 degrees Fahrenheit during the flight. RockOn workshop payloads do not use thermal control, but the choice to use a thermal control system will be left to the customer.

5.6. Electrical Design Requirements

Payload electronics shall be designed to be safe and practical. Each payload is required to have a 1.SYS.1 or 1.SYS.2 activation system described in Section 5.2.2. It is highly recommended that a latching relay system be used with 1.SYS.2 where the shorting connection allows a mechanical G-switch to complete the circuit and activate the payload upon ascent.

Any payload that uses alternating current or circuitry with substantial switching (relays) shall notify COSGC as soon as possible during the design phase. Fast switching can induce magnetic interference that must be approved by WFF.

5.7. Electrical Harnessing and Staking

All payloads shall harness wires with a nylon lacing tape or the equivalent. Wire harnesses that are excessively long shall be staked to the structure to mitigate the risk of disconnects during flight. It is also highly recommended that all connectors and IC sockets be tied and staked in place using aerospace grade Room Temperature Vulcanizing (RTV) sealant, or at minimum, hot glue. An example of a well-harnessed and staked payload can be seen below in Figure 14.

![Figure 14: Staking and Harnessing](image)

6.0 PAYLOAD HARDWARE INTEGRATION

The customer shall furnish a complete, functional, and fully integrated payload to COSGC and WFF on the day of visual inspections, tentatively June 18, 2020, that meets all of the requirements of this document. The customer’s payload shall pass pre-flight inspections by members of both COSGC and WFF to ensure compliance with the requirements of this document. A Launch Readiness Review (LRR) will be held two (2) weeks before launch. Integrated payloads shall be delivered to WFF no later than
six (6) days before launch (Friday, June 19 at 8:00 AM). Wallops Flight Facility may require Moment of Inertia and/or vibration testing prior to integration to the sub-SEM ring assembly. Final integration of the customer’s RockSat payload canister to the sub-SEM ring assembly will occur three days prior to launch (Monday, June 22). After the customer’s RockSat-C payload canister has been integrated to the sub-SEM ring assembly, there will be no access to the payload.

7.0 PAYLOAD TEST REQUIREMENTS

Testing of the payload shall be performed by the customer to ensure payload functionality and survivability. All tests shall be documented and/or recorded for the testing reviews, whose dates are established in Section 9.

7.1. Structural Testing
The customer shall perform any testing that he/she sees fit to ensure that his/her payload will survive the launch environment. In addition to the testing completed by the customer, WFF will perform a three axes vibration test the week before launch.

7.2. Environmental Testing
It is not required but recommended that the customer run a full mission simulation in a vacuum chamber.

7.3. Day in the Life Testing (DITL)
The customer is required to run at least two (2) full mission simulations to demonstrate functionality of the payload. This test should consist of the payload being operated on the bench as an integrated payload for the entire mission life (less than 30 minutes). The results of these tests will be presented at the weekly teleconferences as indicated on the schedule.

7.4. Visual Inspection Testing
The customer is required to fully integrate the payload and perform a visual inspection using the same procedure as that being followed when the payload is checked at the Refuge Inn on June 11, 2020. This test ensures that payloads interface with the canister correctly and that there are no shorts between the canister and the payload (requirement discussed in Section 5.2.2.2.). The procedure is included in Appendix D, and a completed and initialed copy must be sent to COSGC before June 1, 2020. This copy will be used at the Refuge Inn for the official inspection on Thursday, June 18, 2020. All payloads will be held after the initial check-in and after the final check-in on Sunday, June 21, 2020. The RockSat-C Program Manager will be responsible for ensuring that all the payloads make it on base at the correct time. Wallops Flight Facility has strict requirements and due to the tight schedule of events, payloads must be completely ready for inspection upon arrival at the facility. Having the payloads pre-checked allows for safer, quicker integration for both the vibe test and flight integration.

8.0 SELECTION PROCESS

Any educational institution wanting to fly shall submit the IFF either via email or by fax no later than September 16, 2019 at 5:00 PM MDT. The IFF will be emailed along with this document upon its release.
The IFFs will be reviewed, and initial selections will be made by September 18, 2019. Initially selected candidates will be chosen based on responses to the questions on the IFF. Institutions that submit an IFF will be expected to pay a refundable earnest deposit of $1,000 no later than October 11, 2019. All payments must be in the form of a check made payable to the University of Colorado (Section 1.6.1). At this point in the selection process, there could be more candidates than available positions. Over the next three months, candidates will refine their mission and complete three (3) design reviews. The first review is the Conceptual Design Review (CoDR), which will mature to a Preliminary Design Review (PDR), with a Critical Design Review (CDR) used as a final design review before down-selects for a spot on the June 2020 flight. In addition to these reviews, candidates will attend monthly update teleconferences. Each of these presentations and teleconference reports will be reviewed and used to determine the flight worthiness of all initially selected candidates.

No later than January 8, 2020, COSGC and WFF will award flight opportunities to the six RockSat-C payload canisters that are the most mature and ready to continue in the engineering process. Up to two canisters of customers may be kept as reserve payloads, and will continue in the design process.

If an institution is NOT selected at final down select, their earnest deposit will be refunded in full. Those institutions that are awarded flights will continue to the next step of the engineering process. The six selected canisters and the reserve customer(s) will make the first non-refundable installment on February 10, 2020. Once the initial payment is received, the customer’s space has been reserved and no refunds will be issued for any reason; this includes but is not limited to failing to complete the payload before launch or being removed from flight by either Wallops Flight Facility or COSGC. The final non-refundable installment will be due April 10, 2020. For further details concerning the engineering/design process after final down select, please see the schedule in Section 9.

In the event that a customer cannot complete his/her payload or does not follow requirements set forth in this document, a reserve customer will become a primary customer, and the primary customer will not be refunded or compensated in any way. In the event that the six finalists all launch, the reserve customer(s) will be refunded the cost of flight, but will NOT be compensated for any hardware, travel, or miscellaneous expenses incurred in the engineering process.

9.0 SCHEDULE

The table and calendar available on the RockSat-C website is a schedule with key deadlines and reviews that the customer should be aware of. The schedule page of the RockSat-C website can be found below. Please note due dates for presentations and plan accordingly since some fall on test weeks or school vacations. Being on time is a critical part of successful participation in the RockSat-C program. The RockSat-C website will have the most up-to-date schedule; the schedule is subject to change. A breakdown of the events for the week preceding the launch is shown in Appendix C.

Schedule: https://spacegrant.colorado.edu/rs-c-2020-resources/schedule
10.0 Appendix A: Structural Drawings

Figure 15: Lower End Cap Mechanical Drawing
Figure 16: Upper End Cap Mechanical Drawing
Figure 17: RockSat Canister Skin Mechanical Drawing
Figure 18: RockSat Skin Mechanical Drawing – 0.125” thick
Appendix B: PFA Tubing and Tube Connections

PFA Tube Fittings

- Temperatures from 70 to 400°F (20 to 204°C)
- Working pressures up to 275 psig (19.0 bar)
- Sizes from 1/8 to 1/2 in.
2 PFA Tube Fittings

Features
- Audible click ensures tubing is inserted properly.
- Visual indication of proper pull-up:
  - no gap between body hex and nut
  - hex flat alignment.
- Smooth, molded internal wetted surfaces reduce potential for system contamination.
- Grooved tubing allows for higher working pressure.
- Wrench assembly avoids the potentially unsafe practices of hand assembly and disassembly.

Materials
- Fittings—Molded PFA/ASTM D3307 Type I

Pressure-Temperature Ratings
Pressure ratings are for Swagelok® PFA tube fittings used with properly grooved Swagelok PFA tubing.

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Ordering Information and Dimensions
Dimensions, in inches (millimeters), are for reference only and are subject to change. Dimensions shown with Swagelok nuts finger-tight. E dimensions refer to the minimum opening.

Unions

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<td>A</td>
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<tr>
<td>1/8</td>
<td>PFA-220-6</td>
<td>1.45 (36.8)</td>
</tr>
<tr>
<td>1/4</td>
<td>PFA-420-6</td>
<td>1.70 (43.2)</td>
</tr>
<tr>
<td>3/8</td>
<td>PFA-620-6</td>
<td>1.80 (45.7)</td>
</tr>
<tr>
<td>1/2</td>
<td>PFA-820-6</td>
<td>2.05 (52.1)</td>
</tr>
</tbody>
</table>

Bulkhead Unions

<table>
<thead>
<tr>
<th>Tube Size in.</th>
<th>Ordering Number</th>
<th>Dimensions, in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>1/4</td>
<td>PFA-420-68</td>
<td>2.42 (61.6)</td>
</tr>
</tbody>
</table>

*Panel hole size is 0.79 in. (17.8 mm); maximum panel thickness is 0.64 in. (16.2 mm).

Reducing Unions

<table>
<thead>
<tr>
<th>Tube Size in.</th>
<th>Ordering Number</th>
<th>Dimensions, in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>3/8 to 1/4</td>
<td>PFA-620-6-4</td>
<td>1.77 (45.0)</td>
</tr>
<tr>
<td>1/2 to 1/4</td>
<td>PFA-820-6-4</td>
<td>1.91 (48.5)</td>
</tr>
<tr>
<td>1/2 to 3/8</td>
<td>PFA-820-6-6</td>
<td>1.94 (49.3)</td>
</tr>
</tbody>
</table>
### Ordering Information and Dimensions

Dimensions, in inches (millimeters), are for reference only and are subject to change. Dimensions shown with Swagelok nuts finger-tight. E dimensions refer to the minimum opening.

#### Union Elbows

<table>
<thead>
<tr>
<th>Tube Size in.</th>
<th>Ordering Number</th>
<th>Dimensions, in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>PFA-220-9</td>
<td>0.91 (23.1) 0.50 (12.7) 0.09 (2.3) 1/2</td>
</tr>
<tr>
<td>1/4</td>
<td>PFA-420-9</td>
<td>1.13 (29.5) 0.90 (23.0) 0.10 (2.5) 5/8</td>
</tr>
<tr>
<td>3/8</td>
<td>PFA-620-9</td>
<td>1.23 (31.3) 0.87 (22.1) 0.20 (5.1) 13/16</td>
</tr>
<tr>
<td>1/2</td>
<td>PFA-820-9</td>
<td>1.45 (36.8) 0.90 (22.9) 0.41 (10.4) 1</td>
</tr>
</tbody>
</table>

#### Union Tees

<table>
<thead>
<tr>
<th>Tube Size in.</th>
<th>Ordering Number</th>
<th>Dimensions, in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>PFA-220-3</td>
<td>1.06 (26.9) 0.91 (23.1) 0.50 (12.7) 1/2</td>
</tr>
<tr>
<td>1/4</td>
<td>PFA-420-3</td>
<td>1.28 (32.5) 1.13 (28.8) 0.60 (15.3) 5/8</td>
</tr>
<tr>
<td>3/8</td>
<td>PFA-620-3</td>
<td>1.56 (39.7) 1.23 (31.3) 0.87 (22.1) 13/16</td>
</tr>
<tr>
<td>1/2</td>
<td>PFA-820-3</td>
<td>1.90 (48.3) 1.45 (36.8) 0.90 (22.9) 1</td>
</tr>
</tbody>
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#### Male Connectors

<table>
<thead>
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<th>Pipe Size in.</th>
<th>Ordering Number</th>
<th>Dimensions, in. (mm)</th>
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</thead>
<tbody>
<tr>
<td>1/8</td>
<td>1/8</td>
<td>PFA-220-1-2</td>
<td>1.21 (30.7) 0.60 (15.2) 0.19 (4.8) 1/2</td>
</tr>
<tr>
<td>1/4</td>
<td>1/8</td>
<td>PFA-420-1-2</td>
<td>1.36 (34.5) 0.60 (15.2) 0.19 (4.8) 5/8</td>
</tr>
<tr>
<td>3/8</td>
<td>1/4</td>
<td>PFA-620-1-4</td>
<td>1.54 (39.1) 0.87 (22.1) 0.29 (7.4) 13/16</td>
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<tr>
<td>1/2</td>
<td>3/8</td>
<td>PFA-820-1-8</td>
<td>1.74 (44.3) 1.45 (36.8) 0.41 (10.4) 1</td>
</tr>
</tbody>
</table>

#### Male Elbows

<table>
<thead>
<tr>
<th>Tube Size in.</th>
<th>Pipe Size in.</th>
<th>Ordering Number</th>
<th>Dimensions, in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>1/8</td>
<td>PFA-220-2-2</td>
<td>0.91 (23.1) 0.50 (12.7) 0.09 (2.3) 1/2</td>
</tr>
<tr>
<td>1/4</td>
<td>1/8</td>
<td>PFA-420-2-2</td>
<td>1.13 (28.7) 0.60 (15.2) 0.09 (2.3) 5/8</td>
</tr>
<tr>
<td>3/8</td>
<td>1/4</td>
<td>PFA-620-2-4</td>
<td>1.23 (31.2) 0.87 (22.1) 0.20 (5.1) 13/16</td>
</tr>
<tr>
<td>1/2</td>
<td>3/8</td>
<td>PFA-820-2-6</td>
<td>1.45 (36.8) 1.45 (36.8) 0.41 (10.4) 1</td>
</tr>
</tbody>
</table>

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Swagelok

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Colorado Space Grant Consortium

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1/16/2020

Rev. 12
### Ordering Information and Dimensions

Dimensions, in inches (millimeters), are for reference only and are subject to change. Dimensions shown with Swagelok nuts finger-tight. E dimensions refer to the minimum opening.

**Back Ferrules**

- 1/4" PFA-424-1
- 3/8" PFA-624-1
- 1/2" PFA-824-1

© 1/8" back窄口 integral with nut.

**Front Ferrules**

- 1/4" T-203-11H
- 3/8" PFA-623-1
- 1/2" PFA-823-1

© PTFE material.

**Plugs**

- 1/4" PFA-420-P
- 3/8" PFA-620-P
- 1/2" PFA-820-P

© 1/8" back窄口 integral with nut.

### Nuts

- 1/8" PFA-222-C6
- 1/4" PFA-422-1
- 3/8" PFA-622-1
- 1/2" PFA-822-1

© 1/8" back窄口 integral with nut.

### Installation

- **PFA tubing** MUST be grooved for use with PFA tube fittings. Use the Swagelok groove cutter tool.

1. Insert grooved PFA tubing into the Swagelok PFA tube fitting until a clicking sound is heard.
2. While holding fitting body steady, tighten the blue nut until there is no gap between the nut and body hexes.
3. Continue tightening until the nut and body hexes are aligned.

### PFA Tubing and Tools

For PFA tubing in accordance with ASTM D3807 Type B, in 1/8" to 1 in. and 9 to 12 mm sizes, see the Swagelok Hose and Fitting Tubing catalog, MS-01-180. The catalog also contains ordering information for the Swagelok groove cutter tool.

### Warranty Information

Swagelok products are backed by The Swagelok Limited Lifetime Warranty. For a copy, visit swagelok.com or contact your authorized Swagelok representative.

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**Safe Product Selection**

When selecting a product, the total system design must be considered to ensure safe, trouble-free performance. Function, material compatibility, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system designer and user.

**Caution:** Do not mix or interchange parts with those of other manufacturers.
12.0 Appendix C: Multipurpose Port Explanation

Terms & Baseline Layout Explanation:

All the experiment payloads are contained within canisters, which are mounted inside of the rocket skin. The canisters have a window cut into both sides, 180 degrees opposite and 90 degrees offset from the wire-way. See the RockSat-C User’s Guide Appendix for detailed mechanical drawings of the canister with dimensions. Figure 1 below shows a typical canister.

![Figure 1. Experiment Canister](image)

The ports are holes in the rocket skin, Figure 2.
Each of the port holes will be covered by what we call a "door" - a cover with an o-ring to seal the door and port hole. It also has another hole for the actual port pocket. Figure 3 shows a detailed view of the door and pocket. Figure 4 provides another view of the door and port integrated onto the rocket (the screws are not shown in the figure, but are fully screwed and torqued before flight).
Figure 4. Port door with pocket (2016 design) integrated into rocket skin

The port pocket integrates into the door and holds the hardware. It is a smaller, approximately 2.5” x 2.5”, square with a depth of approximately 1.4” (depending on location in the pocket) that each team will mount its components into. The pocket also includes the wire connector: a hermetically sealed connector. The pocket includes a groove for an o-ring on the outside face that mounts to the door for integration onto the rocket skin. See Figures 5 and 6 for images of the two pocket options. Note that the ports are made of aluminum, and the blue color is an artifact of the modeling software not an accurate indication of the pocket color.

Figure 6. Port pocket, 9-Pin Connector  Figure 6. Port Pocket, Dual SMA Connectors
Notice Figure 5 utilizes a 9-pin connector while Figure 6 includes two SMA connectors. These connectors are also shown in Figure 7a and 7b. The pocket also has an optional, modifiable cover (Figure 7c). This cover is also included in the design files and is optional. The pocket and cover are the items that Wallops will provide to integrate each team’s hardware; the pocket CANNOT be modified (the sealed part) but the cover can be modified if a team choose to use it.

![Figure 7. (a) SMA connector; (b) 9-pin connector; (c) Optional pocket cover](image)

The components in each pocket should be contained within the pocket. If a team would like to extend anything outside of this, contact rocksatprogram@gmail.com.

Wallops Flight Facility machines the port pockets and covers. They will create two exact copies: one to send to teams in approximately April for testing and fit checks, and one for use in pre-integration testing, (i.e. pressure testing). Upon arrival at the Refuge Inn for check-in on Thursday, ALL components for the port should be completely ready for integration (include the cables to interface with the port). On Friday, hardware will be integrated into the Wallops version of the port that has
been tested with the rocket prior to arrival. Teams are NOT allowed to permanently attached (i.e. epoxy) components to the port pocket, but teams may permanently attach components to the cover if it is being used. The cover that is sent in approximately April will be the one that is flown if the team has chosen to use and/or modify it.

NOTES:

1. The pictures in Figure 2-3 both show modified port covers. Figure 2 shows the original port cover with additional holes and interfaces to accommodate the teams mission. Figure 3 shows a new cover that was machined by the team.
2. The RockSat-C Google Drive Resources folder, linked on the website, includes models of the port pocket, cover, and canister in SolidWorks, STL, and STP formats. Contact rocksatprogram@gmail.com if you need to request a different format.
3. Failure to arrive to your integration Check-In with all port hardware ready for integration could result in loss of the use of the port for flight.
4. If something is not clear, ASK! DO NOT JUST ASSUME! The program manager (rocksatprogram@gmail.com) will be happy to help early, rather than have to remove your port from flight because something was not clarified well before arrival at Wallops.
### 13.0 Appendix D: Launch Week/Integration Agenda

**Launch schedule subject to change**

#### Day 0, Wednesday (June 17, 2020)
Recommended day for travel, teams arrive morning and afternoon

#### Day 1, Thursday (June 18, 2020)

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 A</td>
<td>Chris and Audrey visually inspect payloads. Payload will be collected by Chris and Audrey after inspection</td>
<td>Refuge Inn</td>
</tr>
<tr>
<td>9:00</td>
<td>Stevens Institute of Technology/Hobart and William Smith</td>
<td>Refuge Inn</td>
</tr>
<tr>
<td>10:00</td>
<td>University of Delaware/University of Wisconsin-Milwaukee</td>
<td>Refuge Inn</td>
</tr>
<tr>
<td>11:00</td>
<td>West Virginia University</td>
<td>Refuge Inn</td>
</tr>
<tr>
<td>1:00 P</td>
<td>Clemson University/Delgado Community College</td>
<td>Refuge Inn</td>
</tr>
<tr>
<td>2:00-3:00 P</td>
<td>Pick up security badges at Refuge Inn. Bring valid drivers license or US Passport (or Green Card, if applicable)</td>
<td>Refuge Inn</td>
</tr>
<tr>
<td>2:00</td>
<td>Langston University</td>
<td>Refuge Inn</td>
</tr>
<tr>
<td>3:00</td>
<td>Temple University</td>
<td>Refuge Inn</td>
</tr>
</tbody>
</table>

#### Day 2, Friday (June 19, 2020)

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 A</td>
<td>Arrive at Wallops Visitors Center to pick up security badges. Bring Valid driver’s license or US Passport (or Green Card, if applicable).</td>
<td></td>
</tr>
<tr>
<td>7:30</td>
<td>Breakfast available at WFF cafeteria</td>
<td>Cafeteria</td>
</tr>
<tr>
<td>7:45</td>
<td>Arrive at WFF and get through security</td>
<td></td>
</tr>
<tr>
<td>8:00</td>
<td>Safety briefing</td>
<td>Building F10</td>
</tr>
<tr>
<td>8:15</td>
<td>Set up payloads</td>
<td>Building F10</td>
</tr>
<tr>
<td>9:00</td>
<td>Wallops visual inspections and weight check</td>
<td>Building F10</td>
</tr>
<tr>
<td>10:00</td>
<td>Stack integration/vibration/spin testing</td>
<td>Building F10</td>
</tr>
<tr>
<td>11:30</td>
<td>Lunch</td>
<td>Chesapeake Room</td>
</tr>
<tr>
<td>12:15 P</td>
<td>Testing continues</td>
<td>Building F10</td>
</tr>
<tr>
<td>2:00</td>
<td>Stack disassembly and payload inspections</td>
<td>Building F10</td>
</tr>
</tbody>
</table>
Day ends

Day 3, Saturday (June 20, 2020)

9:00 A
Refuge Inn Conference room open and available for action items
Refuge Inn

10:00 P
Refuge Inn Conference room closed for the evening
Refuge Inn

Day 4, Sunday (June 21, 2020)

10:00 A
Refuge Inn Conference room open and available for action items
(RockSat)

3:00 P
Payloads re-inspected for integration Monday
Refuge Inn
**Same order as Check-Ins on Thursday June 13, Check-Ins every half hour**
Payloads will be collected by Chris and Audrey at the end of inspection. **Note:**
Teams will not have access to their experiment after they have been collected.

9:00 P
Refuge conference room closed for the evening
(RockSat)

Day 5, Monday (June 22, 2020)

6:30-8:00 A
Breakfast available at WFF cafeteria
Cafeteria

8:00
Arrive and get through security

8:15
Final Wallops inspections
Building F10

9:00
Integration of forward section begins
Building F10

11:30
Lunch
Chesapeake Room

1:00 P
Integration continues
Building F10

5:00
End of the day, forward section integration complete
**Payloads in the aft section will remain in F10 overnight**

Day 6, Tuesday (June 23, 2020)

6:30-8:00 A
Breakfast at WFF cafeteria
Cafeteria

8:15 A
Payloads in aft section - arrive and get through security

8:30
RockOn Workshop integration begins
Building F10

**Attendance required for payloads in aft section**
**Attendance is required for all payloads utilizing ports**
RockSat Payload Canister User’s Guide

11:30  Payloads in forward section - arrive and get through security  (RockSat-C)

12:30 P  Lunch  Chesapeake Room

**Three options after lunch – Wallops Tour, F10 Rocket activity, or take rest of day off.**

12:30  (120)  Wallops Tour Option #1*  {3 Groups of 30}  Meet in Chesapeake Room
2:30  (120)  Wallops Tour Option #2*  {3 Groups of 30}  Meet at F10

* Both tours are essentially the same Option #1 will include the Machine Shop and Option #2 will include the Balloon Program Office. You must select one tour option as we are sharing these tours with RockOn! students. If you are a team using a port or team in the aft section, one team member must be present at F-10 at all times, so make sure you switch off on tours!

12:30 P  RockOn/RockSat-C integration continues  Building F10
3:00  Skin integration and spin test  Building F10
5:00  Pressure test begins  Building F10

**Day 7, Wednesday (June 24, 2020) – Subject to Change**

6:45-7:30 A  Breakfast available at WFF cafeteria  Cafeteria
7:00-7:30  Distribution of Shirts for RockOn and RockSat-C
8:45  Future Flight Opportunities with  Building F3
Audrey Viland and Leina Hutchinson
RockSat-C and X Program Manager + Introduction to RockSat Presentations
9:00  Presentations from RockSat-C and RockSat-X teams.
11:40  Wallops Flight Facility Overview and Sounding Rocket Programs  Building E100
– with Giovanni Rosanova, Chief, Sounding Rockets Program Office, WFF

12:20  Lunch (Provided) – Continue to eat during guest talk  Building F-3

1:10  (10)  Launch Day Logistics OverviewBuilding E-100
1:20  (30)  Drive to Launch Site for Pad Pictures
1:50  (45)  Pad pictures – Leave cell phones, key fobs, and other RF devices in your car

**NOTE** – This may take longer and you will be outside the whole time. Please bring bug spray, water, and a hat. Please use the restroom before leaving building E-100.

**Day 8, Thursday (June 25, 2020)**

4:00 A  Travel to launch viewing site (own vehicles)  Wallops Island
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:30</td>
<td>Wait for launch</td>
<td>Wallops Island</td>
</tr>
<tr>
<td>5:30</td>
<td>Launch!</td>
<td>Wallops Island</td>
</tr>
<tr>
<td>7:00</td>
<td>Recovery Operations - May return to hotel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Breakfast available in Wallops Cafeteria</td>
<td>Cafeteria</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:00-1:00 P</td>
<td>Lunch in Wallops Cafeteria</td>
<td>Cafeteria</td>
</tr>
<tr>
<td>12:30</td>
<td>Can / Rocket De-integration</td>
<td>Building F10</td>
</tr>
<tr>
<td>1:30</td>
<td>Can De-integration</td>
<td>Building F10</td>
</tr>
<tr>
<td>3:30</td>
<td>Canister re-check-in</td>
<td>Building F10</td>
</tr>
<tr>
<td>5:00</td>
<td>Celebration Dinner</td>
<td>Bill’s Seafood</td>
</tr>
<tr>
<td></td>
<td>- Possible: teams discuss unique results from data and the workshop (learned, liked, disliked, etc)</td>
<td></td>
</tr>
<tr>
<td>7:00</td>
<td>Pack up, clean up and head home!</td>
<td>Refuge Inn</td>
</tr>
</tbody>
</table>
14.0 Appendix E: Visual Inspection Procedure

This procedure was used for the RockSat 2019 visual inspections and is subject to change. The most updated version can be found on the website. However this copy can be used as a guide for planning and preparation for the test.

---

## RockSat 2019 Payload Check-In Procedure

<table>
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<th>Revision</th>
<th>Date</th>
<th>Authored By</th>
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<td>00</td>
<td>3-09-2010</td>
<td>Shawn M. Carroll</td>
<td>Initial Release</td>
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<td>4-26-2010</td>
<td>Shawn M. Carroll</td>
<td>Proofed Prior To Website Release</td>
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<tr>
<td>02</td>
<td>6-13-2010</td>
<td>Shawn M. Carroll</td>
<td>Added University and Pass Box to Cover Page</td>
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<tr>
<td>03</td>
<td>4-15-2011</td>
<td>Emily Logan</td>
<td>Update for 2011 launch</td>
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<td>04</td>
<td>5-6-2011</td>
<td>Emily Logan</td>
<td>Check-in schedule updates</td>
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<td>05</td>
<td>5-12-2011</td>
<td>Emily Logan</td>
<td>Check-in schedule updates</td>
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<tr>
<td>06</td>
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<td>Emily Logan</td>
<td>Modified for integration check-in</td>
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<tr>
<td>07</td>
<td>4-8-2013</td>
<td>Emily Logan</td>
<td>Check-in schedule updates, updated section testing canister voltage</td>
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<td>Becca Lidvall</td>
<td>Schedule updates, minor changes</td>
</tr>
<tr>
<td>09</td>
<td>4-3-2015</td>
<td>Becca Lidvall</td>
<td>Schedule updates, minor changes</td>
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<td>10</td>
<td>3-29-2016</td>
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<td>Schedule updates, added ports</td>
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<td>3-15-17</td>
<td>Leina Hutchinson</td>
<td>Schedule updates, minor changes</td>
</tr>
<tr>
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<td>6-10-17</td>
<td>Leina Hutchinson</td>
<td>Update to check-in procedure process</td>
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<td>13</td>
<td>4-11-18</td>
<td>Audrey Viland</td>
<td>Updates to check-in, minor changes</td>
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<tr>
<td>14</td>
<td>4-18-19</td>
<td>Audrey Viland</td>
<td>Update to check-in, minor changes</td>
</tr>
</tbody>
</table>
## Approvals

RockSat Student PM: Audrey Viland Date: 6/13/19

Principle Investigator (PI): Chris Koehler Date: 6/13/19

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1.0 Introduction

1.1. Test Purpose and Objectives
The purpose of this document is to outline the testing procedure needed to verify that the payload complies with the requirements of the 2019 RockSat program. Compliance with the below requirements will ensure that the payload is safe and ready for environmental testing at Wallops Flight Facility to take place on 14 June 2019. Payloads that do not pass the checklist below may be removed from the flight if the issue cannot be easily remedied prior to the above said environmental test.

1.2. Team Check-In Schedule
Please note that your payload should be completely integrated as though it were going to check in and go straight to a vibe table. Each check-in is scheduled for a block of 60 minutes. If you have a canister partner, the entire can must be integrated and put together for check-in. Universities will be checked in as canisters, with a separate document for each team to verify electrical compliance.

<table>
<thead>
<tr>
<th>SCHEDULE</th>
<th>University(ies)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 AM</td>
<td>Stevens Institute of Technology/Hobart and Williams Smith Colleges</td>
</tr>
<tr>
<td>10:00 AM</td>
<td>University of Delaware/University of Wisconsin Milwaukee</td>
</tr>
<tr>
<td>11:00 AM</td>
<td>West Virginia University</td>
</tr>
<tr>
<td>12:00 PM</td>
<td>Lunch -- no check-ins</td>
</tr>
<tr>
<td>1:00 PM</td>
<td>Clemson University/Delgado Community College</td>
</tr>
<tr>
<td>2:00 PM</td>
<td>Langston University</td>
</tr>
<tr>
<td>3:00 PM</td>
<td>Temple University</td>
</tr>
<tr>
<td>4:00 PM</td>
<td>--</td>
</tr>
<tr>
<td>5:00 PM</td>
<td>Dinner -- no check-ins</td>
</tr>
</tbody>
</table>
Quality Assurance (QA) Precautions

1.3. QA provisions
To ensure a path of compliance, each payload will be subjected to the procedure and testing outlined in this document. Additionally, each payload will have its own Preliminary Payload Check-In document, and results will be directly recorded into it. This check-in test will be performed once by the team for redundancy to ensure the payload is ready for official check in at the Refuge Inn the day before environmental testing. This is labeled as “environmental” on the test check boxes below. The payload will be inspected again before rocket integration. This is labeled as “integration” on the test check boxes below.

Please scan your completed and signed form as PDF and email it to rocksatprogram@gmail.com no later than 5:00pm MST on Monday, June 3rd, 2019.

Failure to complete this check-in procedure and ensure that it is received by June 3rd may result in your payload’s removal from the flight. The payload will be checked on Thursday, June 13th, 2019 prior to arrival for environmental testing at Wallops. Finally, the payload will be re-checked Sunday, June 16th to ensure weekend work has not created any major changes in the payload. After passing this check, the payload will be sealed with a sticker. All payload will also be left with the RockSat-C Program Manager after each check-in. At this point, you will not have access to your payload until after testing on June 14th.
2.0 Test Resources

2.1. Facilities
• Refuge Inn Conference Room

2.2. Equipment

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Quantity</th>
<th>Needs to be Cleaned (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Scale (accurate to 0.1 lbf)</td>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>2 Multimeter</td>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>3 Flash Light</td>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>4 ¼” Female NPT Connector</td>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>5 Writing Utensil</td>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>6 Camera</td>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>7 Highlighter</td>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>8 Tape</td>
<td>1 Roll</td>
<td>N</td>
</tr>
<tr>
<td>9 Label Maker</td>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>10 Calculator</td>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>11 Stapler with staples</td>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>12 Approval Stickers</td>
<td>11</td>
<td>N</td>
</tr>
<tr>
<td>13 Directions to WFF</td>
<td>11</td>
<td>N</td>
</tr>
</tbody>
</table>

2.3. Required Personnel
Audrey Viland—RockSat Student PM
Chris Koehler—Principle Investigator (PI)
At least 2 members of the payload team
3.0 Test Procedure

3.1. General Test Concept
The purpose of this check-in is to ensure the customer is in compliance with the requirements set forth by the RockSat-C Program and Wallops Flight Facility. The requirements are listed in the following table.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSC.1 - Weight</td>
<td>RockSat Canister + Payload = 20±0.2 lb</td>
<td>Weighed before MOI and vibe testing.</td>
</tr>
<tr>
<td>RSC.2 - Volume</td>
<td>Contained within RockSat Canister</td>
<td>Constraint in User’s Guide unless pre-approved by RSC manager and WFF. Visual inspection will be completed.</td>
</tr>
<tr>
<td>RSC.3 - CG/MOI</td>
<td>Within 1x1x1” of centroid</td>
<td>Customer responsibility prior to Wallop’s testing. WFF testing determines “go” or “no go.”</td>
</tr>
<tr>
<td>RSC.4 - Electrical</td>
<td>No current flow prior to command line OR g-switch activation</td>
<td>Customer responsibility prior to inspections and Wallops testing. WFF testing determines “go” or “no go.”</td>
</tr>
</tbody>
</table>

This test will first ensure that the required documentation is present. The next phase of testing assumes that the payloads arrive fully integrated and assembled in their respective canisters. The payload will then be visually inspected to ensure that it is contained in the canister. Next, the payload will be massed to ensure that it conforms to the mass requirements. Canisters utilizing an atmospheric port will be checked to make sure that the male ¼” NPT connector on the payload end interfaces to a female ¼” NPT connector. Canisters utilizing a multipurpose port will have the port hardware available for inspection to verify the correct interface is on the instrument.

To ensure that the canister is not shorted to the power source, the canister’s skin potential relative to the power supply’s terminals will be checked. This procedure quantifies the voltage and current on each set of RBF wires. The RBF wires must extend 4 ft. out of the canister. The customer(s) will then be asked to open the canister by removing the top bulkhead and outer skin, which will expose the payloads inside. During the process of removing the top bulkhead and outer skin, it will be verified that the internal structure bolts to at least 4 out of 5 of the top bulkhead attachments and at least 4 out of 5 of the bottom bulkhead attachments. Additionally, the general structure of the payload stack and potting will be checked. Finally, the battery type will be verified, and implications will be
discussed with the team.
3.2. Documentation Check
The purpose of the documentation check is to ensure that your payload is well defined and if there are any questions about structures or electronics, the information will be readily available to help integration proceed as smoothly as possible. The documentation **must be in a binder**.

<table>
<thead>
<tr>
<th>Documentation Check</th>
<th>Environmental Initial</th>
<th>Integration Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The payload notebook contains the original or a copy of the completed check-in procedure turned in 6/3/19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. The payload notebook contains a full set of system schematics (computer generated)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. The payload notebook contains a full set of mechanical drawings (computer generated)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. The payload notebook contains data sheets and mechanical specifications that would be deemed relevant to someone inspecting a payload. Non-essential data sheets and design reviews should at minimum be available in electronic format.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. The payload notebook contains some type of structural integration procedure specific to this team’s payload.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Action Items:**
3.3. **Canister Containment Check**

The canister containment check verifies that the customer is in compliance with requirements RSC.2. This section verifies the payload does not extend outside of the canister and that it only connects to the canister through the interfaces designed for that purpose.

<table>
<thead>
<tr>
<th>Canister Containment Check</th>
<th>Environmental Initial</th>
<th>Integration Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The payload is completely contained within the RockSat canister?</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>The payload is not physically connected to any point on the RockSat canister other than the top and bottom bulkheads?</td>
<td></td>
</tr>
</tbody>
</table>

**Action Items:**

**Notes:**
### 3.4. Atmospheric Port Interface Check (If Applicable)

The atmospheric port interface check verifies that the customer design for the atmospheric port can be interfaced with the WFF atmospheric port setup.

<table>
<thead>
<tr>
<th>Atmospheric Port Interface Check</th>
<th>Environmental Initial</th>
<th>Integration Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The payload’s atmospheric tubing fits in the wire-way?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. The terminating ¼” Male NTP connector interfaces to the provided female ¼” NTP connector?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Action Items:**

**Notes:** N/A
### 3.5. Multipurpose Port Interface and Hardware Check (If Applicable)

The multipurpose port interface and hardware check verifies that the customer design for the multipurpose port can be interfaced with the WFF port setup.

<table>
<thead>
<tr>
<th>Atmospheric Port Interface Check</th>
<th>Environmental Initial</th>
<th>Integration Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The experiment hardware fits within the port pocket (and any applicable WFF-allowed extensions)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. The provided cable(s) interfaces with the pass through connector (SMA or 9-pin)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. The provided cable(s) are adequate length to reach port location in cases where port is not next to canister (if applicable, check manifest)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. The experiment hardware in the test port is removable for integration with the WFF flight port (i.e. nothing permanently affixed to the test port)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. All required experiment hardware is present and connected as needed?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Action Items:**

**Notes:** N/A
### 3.6. Weight Check
The weight check verifies requirement RSC.1 from Table 1. The payload is weighed three times and the final weight is an average of the three trials.

<table>
<thead>
<tr>
<th>Weight Check</th>
<th>Environmental Initial</th>
<th>Integration Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power on the scale (accurate to 0.1 lbf)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Zero the scale</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Place the integrated canister on the scale and record the weight below: __________\ lbf</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Remove the canister from the scale and rezero.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Place the integrated canister on the scale and record the weight below: __________\ lbf</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Remove the canister from the scale and rezero.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Place the integrated canister on the scale and record the weight below: __________\ lbf</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Average the weights and record the value below: __________\ lbf ** If anything other than 20±0.2 lbf, highlight this section of the document!!</td>
<td></td>
</tr>
</tbody>
</table>

Action Items:
### 3.7. Neutral Canister Potential Check

The neutral canister potential check verifies requirement RSC.4. The purpose is to ensure that no part of the payload is shorted to the canister, and that there is no voltage potential between the canister and the payload.

<table>
<thead>
<tr>
<th>Neutral Canister Check</th>
<th>Environmental Initial</th>
<th>Integration Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Payload has _________ pairs of at least 4’ (foot) pairs of RBF wires connected, Teflon coated. _________pair(s) activate(s) at launch. _________ pair(s) activate(s) _________ minutes prior to launch.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Payload has one connector tied directly to payload ground easily accessible when the payload is integrated in the canister?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Place the multimeter in a mode to measure voltage *Range: 0-20V unless customer specifies a different range is required</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4 Place one of the multimeter terminals on the skin of the canister and the other on the connection to ground</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>5 Record the voltage measured on the multimeter _________ V **If anything other than 0V, highlight this section of the document!!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Place one of the multimeter terminals on the skin of the canister and the other on the connection to the payload</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Record the voltage measured on the multimeter _________V **If anything other than 0V, highlight this section of the document!!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Action Items:
### 3.8. Voltage/Current Check

The purpose of the Voltage and Current check is to record the voltages across each pair of activation lines for WFF reference. The current check makes sure that there is no current flow across activation lines that activate at launch (even with the Wallops short no current should flow until the g-switch has compressed). It also verifies that current flow through the command line activation pairs does not exceed the 1A maximum.

<table>
<thead>
<tr>
<th>Voltage/Current Check</th>
<th>Environmental Initial</th>
<th>Integration Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Place the multimeter on a mode to measure voltage&lt;br&gt;Range: 0-20V unless customer specifies a different range is required</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>2</strong> Have customer point out which pairs activate at launch and mark with T-0-SCHOOL_NAME using tape or the label maker. If there are multiple lines for launch activation for this payload, add the number of each pair after the school name (1, 2, 3…)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3</strong> Have customer point out which pairs activate prior to launch and mark with T-2-SCHOOL_NAME (2 = minutes prior to launch) using tape or the label maker. If there are multiple lines for launch activation for this payload, add the number of each pair after the school name (1, 2, 3…)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>4</strong> Measure the potential between the positive and ground terminals on each T-0 pair for the current payload:&lt;br&gt;T-0-1__________ V&lt;br&gt;T-0-2__________ V&lt;br&gt;T-0-3__________ V&lt;br&gt;T-0-4__________ V&lt;br&gt;T-0-5__________ V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Voltage/Current Check</td>
<td>Environmental Initial</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>5</td>
<td>Measure the potential between the positive and ground terminals on each T-X for the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>current payload:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T-__-1__________V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T-__-2__________V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T-__-3__________V</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Place the multimeter on the appropriate mode to measure current (switch cable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>configuration if required as well)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>*Range: 0 – 0.1A unless customer specifies a different range is required</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Measure the current through the positive and ground terminals of each T-0 node for</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the current payload:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T-0-1 _________( mA A) {Circle one that applies}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T-0-2 _________( mA A) {Circle one that applies}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T-0-3 _________( mA A) {Circle one that applies}</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>If any current exceeds 0.1 A, highlight this section of the document!</strong></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Place the multimeter on the appropriate mode to measure current (switch cable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>configuration if required as well)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a range the customer feels will not be exceeded on early activation lines.</td>
<td></td>
</tr>
</tbody>
</table>
### Voltage/Current Check

<table>
<thead>
<tr>
<th>9</th>
</tr>
</thead>
</table>

Measure the current through the positive and ground terminals on each T-X node for the current payload:

- T-\(_{\_}\)-1____________( mA A )
  
  {Circle one that applies}

- T-\(_{\_}\)-2____________( mA A )
  
  {Circle one that applies}

- T-\(_{\_}\)-3____________( mA A )
  
  {Circle one that applies}

**If any current exceeds 1 A, highlight this section of the document!**

---

### Action Items:

---

### Notes:

---
3.9. Internal Inspections

The purpose of internal inspections is to make sure the customer is connected to at least 4 of the 5 bulkhead connection points on both the top and bottom of the canister. It also checks that these are the only points where the payload connects to the canister. Additionally, the visual inspection checks the battery type. Finally, this check looks at the quality of staking to make sure the payload is prepared for flight conditions.

14.1.1. NOTE: This section will be completed after all payloads in a canister pass 3.2 – 3.7.

<table>
<thead>
<tr>
<th>Internal Inspections</th>
<th>Environmental Initial</th>
<th>Integration Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  After ALL payloads in a canister have been checked for compliance with sections 3.2 – 3.7, have one customer remove the top bulkhead.</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2  As the customer removes the top bulkhead, verify that the internal structure bolts to 4 out of 5 of the top bulkhead connection points.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3  After the customer removes the skin, verify that the internal structure bolts to 4 out of 5 of the bottom bulkhead connection points.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4  Inspect the payload and ensure that it does not connect to the canister anywhere except the top and bottom bulkheads.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Verify that the payload is NOT planning to CHARGE any rechargeable lithium-ion batteries at Wallops. (Lithium-ion is permitted, but charging is not) Check compliance below:

<table>
<thead>
<tr>
<th></th>
<th>Compliant</th>
<th>Not Compliant</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**(Check One)**
Compliant
Not Compliant

**If not compliant, highlight this section of the document!!**
<table>
<thead>
<tr>
<th>Internal Inspections</th>
<th>Environmental Initial</th>
<th>Integration Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6</strong> Visually inspect the payload’s staking work and rate the quality from 1-10. (1 no staking present; 7 acceptable; 10 consider applying at Wallops)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8 9 10 {Circle One}</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Action Items:**

**Notes:**

---

**Notes:**
4.0 Payload Pictures

4.1. Without Canister

Insert three side view images of the payload, 120 degrees spaced radially
RockSat Payload Canister User’s Guide

Insert one picture of the payload from the top view
4.2. Inside Canister

Insert one picture of the payload through each side window (two pictures total)
5.0 Additional Items for Friday Morning

6.0 Major Issues and/or Concerns

7.0 Directions and Instructions for Arrival at WFF (6/14 only)
Discuss directions, arrival time, and location of safety briefing.

8.0 Signature and Approvals Section: Environmental Testing
Signing below agrees that it has been verified that all highlighted sections of the document have been addressed and resolved, and all action items have been completed for the ___________________________ payload. After signing, the Environmental Testing box on the front of the document may be checked to indicate a pass.

RockSat Student PM: Audrey Viland
Date: 6/13/19

Principle Investigator (PI): Chris Koehler
Date: 6/13/19

Payload team representative (Print and Sign)
Date: 6/13/19

Payload team representative (Print and Sign)
Date: 6/13/19
9.0 Post-vibe Action Items

10.0 Signature and Approvals Section: Integration

Signing below agrees that it has been verified that all highlighted sections of the document have been addressed and resolved, and all action items have been completed for the payload. After signing, the Integration box on the front of the document may be checked to indicate a pass. Once check in is complete, Chris and Audrey will collect the canister and transport it to Wallops for the first day of integration on June 14th, 2019. Teams will have access to their experiment after testing until the Final Check-In process on June 16th, 2019.

RockSat Student PM: Audrey Viland

Date: 6/13/19