

*The ACCESS for
Education Foundation*

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THE ACCESS FOR EDUCATION PROGRAM PAYLOAD USER'S GUIDE

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1. INTRODUCTION

1.1 Purpose

The purpose of this document is to provide an overview of the ACCESS for Education Program (also known as the ACCESS Program), which is administered by The ACCESS for Education Foundation, a non-profit 501(c)(3) corporation. The ACCESS for Education Foundation was formed to carry out the educational mission of Microgravity Enterprises, Inc. (MEI). Under the ACCESS Program, Microgravity Enterprises will provide, free of charge, payload allotments for research and education payloads on every MEI commercial space launch. This document establishes the requirements and guidelines for qualifying payload experiments for flight under the ACCESS Program. In addition, this document establishes the process for participation in the ACCESS Program, as well as the criteria under which ACCESS payloads will be manifested and flown.

1.2 Points of Contact

The ACCESS for Education Program points of contact (POC's) are as follows:

ACCESS for Education Program Contact E-mail	info@ACCESSforEducation.org
ACCESS for Education Program Coordinator	Jeff Ganley Ph. 505-239-8159 Jeff.Ganley@ACCESSforEducation.org
Microgravity Enterprises, Inc. President	Rich Glover Ph. 505-238-7997 Rich.Glover@MicrogravityEnterprises.com
NASA Space Grant Consortium Representative	Chris Koehler University of Colorado - Boulder Koehler@Colorado.edu

1.3 Applicable Documents / References / Links

Please note that not all references and/or links listed below are strictly applicable to all experiment payloads. Some references are provided for information only, and are not meant to convey ACCESS Program requirements. Refer to the later sections of this document to determine applicable payload specific requirements. In addition, all documents listed in this section can be found in the “Program Forms and Documents” section of the ACCESS for Education website.

- ACCESS for Education Program website: <http://www.ACCESSforEducation.org>
- UP Aerospace website: <http://www.upaerospace.com/>
- UP Aerospace SpaceLoft XL™ Mission Planner’s Guide, Rev. 2.3, April 2006.
- CubeSat Program website: <http://www.cubesat.calpoly.edu>
- University Nanosat Program website: <http://www.vs.afrl.af.mil/UNP/>
- NASA Outgassing Data for Selecting Spacecraft Materials System: <http://outgassing.nasa.gov/>
- FED-STD-209E, *Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones*, Sept. 1992 (Superseded by ISO14644-1/-2).
- MIL-STD-1246C, *Product Cleanliness Levels and Contamination Control Program*, Apr. 1994 (Cancelled).
- KSC-C-123H, *Specification for Surface Cleanliness of Fluid Systems*, 25 Sept. 1995.
- AIAA Paper 83-2600, *Venting of Space Shuttle Payloads*, 1983.
- MIL-STD-461E, *Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment*, Aug. 1999.
- MIL-HDBK-5H, *Metallic Materials and Elements for Aerospace Vehicle Structures*, Dec. 1998.
- NASA MSFC-STD-3029, *Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments*, May 2000.
- NASA Materials and Processes Home Page: <http://ndea.jpl.nasa.gov/nasa-mp/mp-hp.htm>
- NASA Parts Selection List (NPSL): <http://nepp.nasa.gov/npsl/>

2. ACCESS FOR EDUCATION PROGRAM

2.1 Overview

The ACCESS for Education Program is a cooperative effort between The ACCESS for Education Foundation and Microgravity Enterprises, Inc., as well as UP Aerospace, Inc. - the launch vehicle provider. Under the ACCESS Program, Microgravity Enterprises is providing, free of charge, research and education payload allotments on every one of their commercial space launches. The objectives of the ACCESS for Education Program are to educate and inspire the future aerospace workforce, and to foster commercial space activities through a national hands-on space experiment flight program.

The ACCESS Program involves two distinct payload allotments - one for inspirational K-12 experiments (i.e. Inspirational Payloads), and a second for (typically University level) research and development experiments (i.e. Research Payloads). This User's Guide outlines the interface details and requirements for both the Inspirational and Research Payloads. In addition, the ACCESS program is divided into two phases. The first phase (i.e. Phase 1) consists of suborbital space flights. The second phase of the program (i.e. Phase 2) will involve orbital space flights in conjunction with Microgravity Enterprises, Inc. commercial orbital return missions. Each phase is described in greater detail below.

Phase 1: The first phase of the ACCESS Program involves suborbital flights for research and educational payloads. Because the UP Aerospace SpaceLoft XL launch vehicle - the baseline for all Microgravity Enterprises, Inc. Phase 1 commercial launches - is a new vehicle, the vehicle environments presented in this document represent best estimate enveloping cases. As such, Phase 1 ACCESS payloads are encouraged to fly sensor packages to quantify the actual environments in support of future ACCESS payloads, as well as MEI commercial payloads (Reference Appendix A).

Phase 2: In Phase 2, Microgravity Enterprises, Inc. will be conducting orbital return flights for commercial payloads. As is the case for all MEI flights, a portion of the payload mass on Phase 2 flights will be dedicated, free of charge, to research and education payloads. Phase 2 activities are expected to begin in approximately 2012. This User's

Guide will be expanded in the future to include greater detail on Phase 2 activities as those details become available. Organizations that are interested in Phase 2 opportunities should monitor the MEI website (<http://www.MicrogravityEnterprises.com>), as well as the ACCESS for Education website (<http://www.ACCESSforEducation.org>), for information and updates. At this time, it is expected that the CubeSat (<http://www.cubesat.calpoly.edu>) and University Nanosat Program (<http://www.vs.afrl.af.mil/UNP/>) designs and requirements will form the basis of the Phase 2 flight payload requirements.

2.2 Experiment Payload Design Focus

As was mentioned previously, the objective of the ACCESS for Education Program is to educate and inspire the future aerospace workforce, and to foster commercial space activities through a national hands-on space experiment flight program. As such, ACCESS Program Research payload organizations are strongly encouraged to design experiment payloads with a space commercialization focus (Reference Appendix A). The ACCESS for Education Program website has additional information on potential space commercialization research topics, including several case studies and supporting educational materials.

At the K-12 grade level (i.e. Inspirational payloads), the primary goal of the ACCESS Program is to allow students to connect with space in a tangible way, with less of a focus on space commercialization activities. A listing of suggested Inspirational experiment payload ideas is given on the ACCESS for Education website.

2.3 Eligibility

Due to International Traffic in Arms Regulations (ITAR) restrictions, the ACCESS Program is limited to U.S. educational institutions; only payloads from U.S. educational institutions are eligible to participate in the ACCESS Program.

For the purposes of the ACCESS Program, ‘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 schools; science museums, etc. Organizations which are not included in the above listing are encouraged to contact the ACCESS Program Coordinator (Reference Section 1.2) 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 who 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 in fact encouraged, under the ACCESS Program.

2.4 ACCESS Program Milestone Schedule

A nominal top level ACCESS Program schedule is given in Table 2-1 below. The purpose of this schedule is to familiarize program participants with the significant milestones in the ACCESS Program process. It is important to note that the schedule given in Table 2-1 has limitations in that it is both top level (i.e. doesn't contain all of the program details, activities and/or requirements), and it is nominal (i.e. it represents a typical flow, which is subject to change due to a number of different influences).

Table 2-1. Top Level ACCESS Program Participant Schedule

Event / Activity	Location	Date / Timeframe
Payload concept development between the payload organization and the ACCESS Program Office	Via e-mail and/or Phone	As Appropriate
Formal entry into the ACCESS for Education Program – complete and submit ACCESS Program Payload Entry Form	Payload Entry Form Due to ACCESS Program Office ¹	Entry Date
Experiment payload hardware development	At Payload Organization Facilities	2 – 18 months ²
Payload development coordination between the payload organization and the ACCESS Program Office (throughout hardware development)	Via e-mail and/or Phone	Periodic

Event / Activity	Location	Date / Timeframe
Submission of the experiment payload Flight Ready Data Submittal (FRDS) for payload manifest	Submission to the ACCESS Program Office ¹	When Ready ³
Experiment payload manifest – acceptance of the experiment payload Flight Ready Data Submittal	Acceptance by the ACCESS Program Office	Manifest Date
Experiment payload flight hardware and (if applicable) procedure finalization	At Payload Organization Facilities	Following Manifest
ACCESS Program Office contacts potential payloads for flight based on manifest rankings ⁴	Payload POC's will be Contacted via Phone and E-mail	L-60 days
Delivery of experiment payload flight hardware	Delivery to ACCESS Program Office	L-30 days
Launch	Spaceport America ⁵	Launch Date
Post flight reporting of experiment payload results	Due to ACCESS Program Office ¹	L+90 days

Notes for Table 2-1:

1. Submit via e-mail to info@ACCESSforEducation.org.
2. Experiment payload development time is highly variable depending on the payload complexity.
3. Payloads should not submit their Flight Ready Data Submittal until their experiment is sufficiently mature to support a flight in as little as 60 days.
4. The time frame between payload manifest and payload launch will be driven by the payload manifest backlog and the launch rate.
5. Spaceport America (<http://www.spaceportamerica.com>), located in southern New Mexico, is the baseline launch location. However, other launch locations are possible.

2.5 Entry Requirements

Formal entry into the ACCESS Program is accomplished by completing the ACCESS Program Entry Form, which can be found in the “Program Forms and Documents” section of the ACCESS for Education website, and in Appendix C of this document. Experiment payload organizations should not submit an Entry Form until they are sufficiently mature as a program to commit to the ACCESS Program.

2.6 Data Submittal Requirements

There are three primary data packages that must be completed under the ACCESS for Education Program: the Entry Form, the Flight Ready Data Submittal (FRDS) and the Post-flight Experiment Results. Further details on the timing and content requirements for these data submittals are outlined in Appendix B.

2.7 Experiment Payload Hardware Requirements

Experiment payload hardware is the responsibility of the educational institution. Each participating organization is expected to provide a fully functioning and flight ready experiment payload that meets all of the requirements of this User’s Guide to the ACCESS Program Office at approximately L-30 days (i.e. 30 days before the scheduled launch date).

2.8 Experiment Payload Manifest

Upon acceptance of the payload Flight Ready Data Submittal (FRDS, see Appendix B) by the ACCESS Program Coordinator, the experiment payload will be added to the relevant payload manifest (separate manifests will be maintained for Inspirational payloads, PL-3 Research payloads, and PTS-4 Research payloads). Each manifest represents a 1-n listing of payloads based on a first-in, first-out process. However, the ACCESS Program Office reserves the right to move payloads with sound commercial potential up on the manifest listing (Reference Appendix A). The official payload manifests will be maintained by the ACCESS Program Coordinator and posted in the “Inspirational Payload Manifest” and “Research Payload Manifest” sections of the ACCESS for Education Program website.

2.9 Flight Manifest Process

For each commercial launch, the ACCESS Program Office will contact experiment payload organizations for flight manifest at approximately L-60 days utilizing the contact information provided in the Entry Form / Flight Ready Data Submittal. For this reason, it is imperative that the payload organizations maintain current contact information in their data submittals to the ACCESS Program Office. Payloads will be polled based on payload type and payload manifest rank (Reference Section 2.8).

3. SPACELOFT XL LAUNCH VEHICLE DESCRIPTION AND CAPABILITIES

3.1 Overview

The UP Aerospace SpaceLoft XL launch vehicle is the baseline vehicle for all Microgravity Enterprises, Inc. suborbital commercial launches. The SpaceLoft XL is a 10.4 inch diameter solid fuel, spin stabilized, single stage vehicle. The SpaceLoft XL vehicle has a land based recovery and is capable of launching approximately 100 lbs of payload to a 70 mile sub-orbital apogee. Additional details on the SpaceLoft XL launch vehicle can be found in the UP Aerospace SpaceLoft XL Mission Planner's Guide (Reference Section 1.3).

3.2 Key Performance Parameters

Refer to Table 3-1 for UP Aerospace SpaceLoft XL launch vehicle Key Performance Parameters.

Table 3-1. SpaceLoft XL Key Performance Parameters

Key Performance Parameter	Value	Note
Maximum Altitude	140 miles	1
Maximum Duration in Microgravity	215 seconds	2
Vehicle Height	20.5 feet	
Vehicle Diameter	10.4 inches	
Vehicle Spin Rate	6 cycles per second	3

Notes for Table 3-1:

1. Nominal Altitude for MEI commercial space launches is 70 statute miles.
2. Nominal duration in microgravity for MEI commercial space launches is approximately 120 - 180 seconds.
3. At motor burnout.

4. ORGANIZATIONAL RESPONSIBILITIES

Organizational responsibilities are as specified in the following sections. Experiment payload organizations should be aware that space activities are inherently risky. While all reasonable care and precautions are taken to ensure a safe space flight, accidents and anomalies can and will happen from time to time. In the unfortunate event of a launch vehicle anomaly or failure, the ACCESS for Education Foundation, Microgravity Enterprises, Inc. and the launch vehicle provider will not be responsible for the damage and/or loss of experiment payload hardware.

4.1 Experiment Payload Responsibilities

Because space activities are both infrequent and expensive, it is the responsibility of the experiment payload organization to maximize the unique opportunity that is being offered in the ACCESS for Education Program. Experiment payload organizations are required to

produce payload experiments that meet the following criteria:

1. The research objectives associated with the experiment payload must be age appropriate, yet well constructed and challenging. The level of complexity of the experiment payload should match both the age level of the students designing the experiment, as well as the capabilities of the payload organization.
2. The mass and/or volume of the experiment payload must be optimized. However, appropriate mass and volume margins (~10-20%) should be carried through the design process.

4.2 Hardware / Functional / Interface Responsibilities

Experiment Payload (Educational Institution Responsibility)

- Experiment payload flight hardware. Including the experiment payload container/interface as specified in Section 5.1.1.
- Shipping of the experiment payload to the ACCESS Program Office for final testing and launch vehicle integration. Note – the ACCESS for Education Foundation is not responsible for experiment payload damage and/or loss during shipping. Appropriate measures (i.e. careful packing, adequate foam padding, moisture protection, ESD protection, etc.) should be taken by the payload organization to ensure safe payload arrival during shipping.
- Safety design/features, as appropriate, for the payload experiment to ensure ground crew and launch vehicle safety.
- Ground handling and maintenance provisions for the experiment payload (e.g. remove before flight items), including pre-flight and post flight procedures, if applicable.
- Operations/Communications (Ground and Space), if applicable, including obtaining all appropriate FCC communication licenses. The use of communication systems requires prior approval from, and close coordination with, the ACCESS Program Office.

Integration, Test and Launch Interfaces (ACCESS Program Office Responsibility)

- Integration of the experiment payload flight hardware to the launch vehicle.
- Static Balance (i.e. C.G.) Testing of the integrated experiment payloads.

- Performance of experiment payload ground handling, maintenance, and checkout procedures; including pre and post flight procedures, as applicable.
- Post flight shipping of the experiment payload back to the experiment organization. Note – the ACCESS for Education Foundation is not responsible for experiment payload damage and/or loss during shipping. Unless otherwise specified, the ACCESS Program Office will utilize UPS and/or FedEx priority shipping for post flight shipping of the experiment payload back to the experiment organization. Special experiment payload shipping requirements, if any, should be coordinated in advance with the ACCESS Program Office.

5. PAYLOAD DESIGN REQUIREMENTS

The following sections provide the payload design requirements for the experiment payloads. It is very important to note that some sections are recommendations as opposed to requirements for the two payload types (i.e. Inspirational and Research), and are marked as such (required sections are unmarked, recommended sections are marked in parentheses).

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

The following sections provide the basic physical requirements (i.e. volume, mass and center of gravity) for the experiment payloads.

5.1.1 Experiment Payload Interface / Container Definition

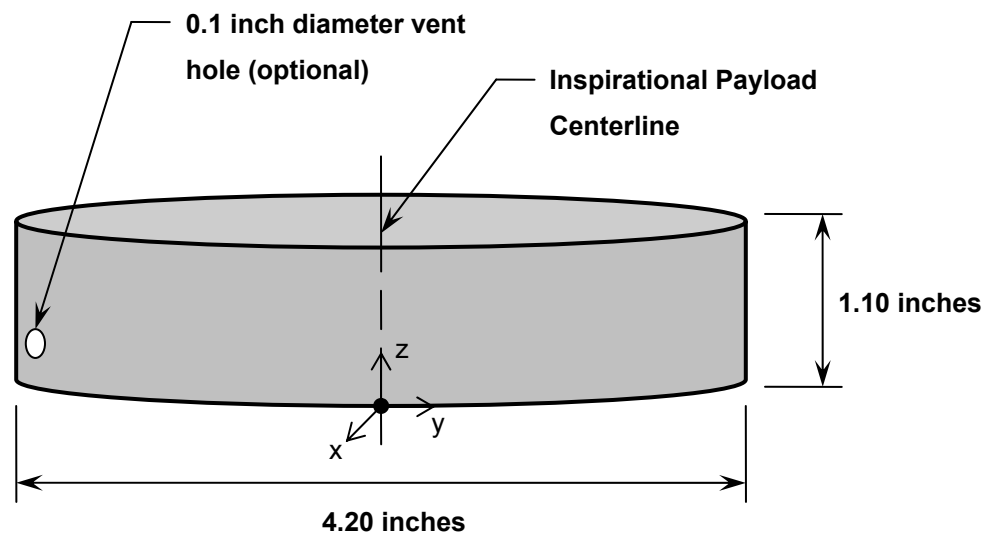
5.1.1.1 Inspirational Payloads

Inspirational payloads must be housed in a payload container as described in this section. The Inspirational payload container defines the allowable static envelope for the Inspirational payloads, and is defined as a cylinder of exterior dimension 4.20 inches in diameter by 1.10 inches tall (Reference Figure 5-1). The Inspirational payload container shall have a minimum outer wall thickness of 0.10 inches, and a minimum top and bottom wall thickness of 0.05 inches.

The entire experiment payload shall fit completely within the Inspirational payload container. Within the Inspirational payload container, the experiment payload can have any

geometry, provided that all requirements of this User's Guide, such as center of gravity (CG), mass, etc., are met.

It is strongly recommended that the Inspirational payloads utilize the Inspirational payload container design given in Appendix D. The ACCESS Program Office has a limited number of these containers pre-fabricated and available for use. Please contact the ACCESS Program Coordinator to determine current availability. If the experiment payload organization chooses to design their own Inspirational payload container, the interior of the container may be customized to meet the needs of the experiment, provided that the minimum container wall thicknesses are met. In addition, the Inspirational payload container shall have an exterior surface as shown in Figure 5-1.



Notes:

1. The payload container vent hole, if utilized, should be located on the perimeter of the container; not the top or bottom of the container.
2. No protrusions from the smooth outer surface of the container are allowed. Payload access ports, wiring pass-throughs, etc. must be coordinated with and approved by the ACCESS Program Office.
3. Mechanical attachment of the experiment payload to the container is not required.

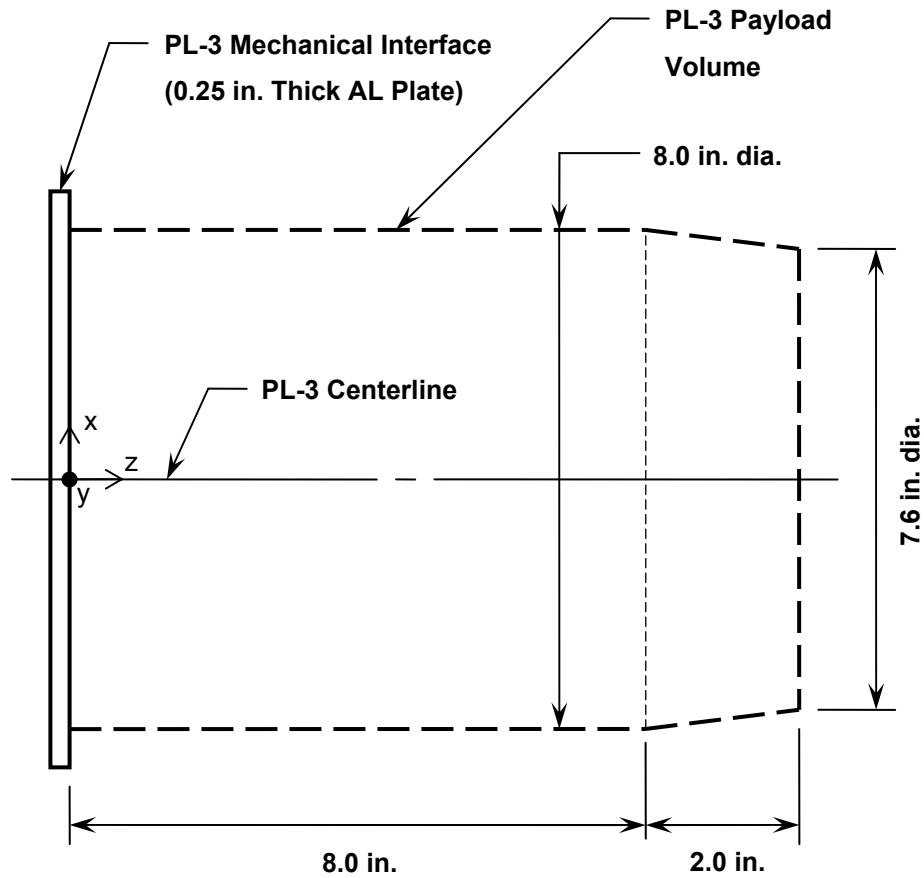
Figure 5-1. Inspirational Payload Container Definition

5.1.1.2 Research Payloads

There are two research payload allotments available on the SpaceLoft XL rocket: Payload Section 3 (PL-3) (Reference Figure 5-2), and Payload Transportation System™ 4 (PTS-4) (Reference Figure 5-3). The PL-3 volume is larger, but doesn't have access to the exterior of the vehicle during flight. The PTS-4 volume is smaller, but has access to the space environment through a small access door on the side of the PTS-4 container. Additional details on the PTS-4 payload allotment can be found in the UP Aerospace SpaceLoft XL Mission Planner's Guide (Reference Section 1.3). In case of conflicts between this User's Guide and other documentation (including the UP Aerospace documentation), the requirements as outlined in this User's Guide shall control.

Research payloads that require additional mass and/or volume than is available in the PL-3 and PTS-4 standard allotments should contact the ACCESS Program Office to discuss additional options. Provisions for (potentially significantly) larger payload allotments exist on all MEI suborbital space flights. However, please note that the degree of space commercialization research and development potential will likely factor heavily in the ACCESS Program Office decision to pursue these types of opportunities.

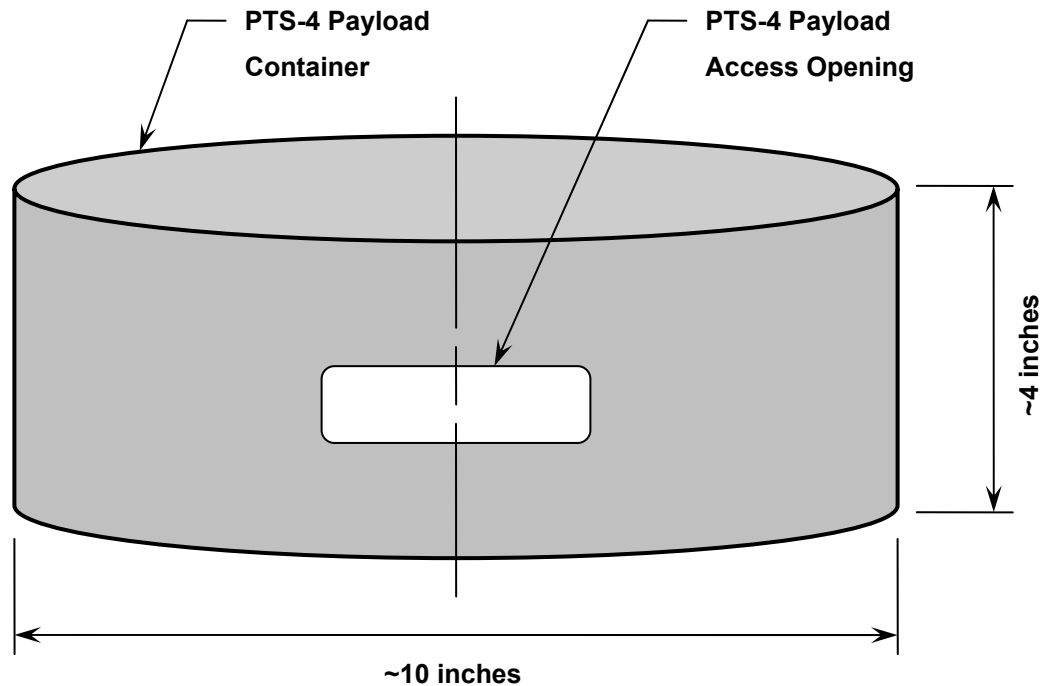
The Research payloads shall fit completely within the volumes given in Figures 5-2 and 5-3. Within the Research payload volumes, the experiment payload can have any geometry, provided that all requirements of this User's Guide, such as center of gravity (CG), mass, etc., are met.



Notes:

1. The payload volume given above is the static envelope (not dynamic / in-flight).

Figure 5-2. PL-3 Research Payload Definition (Volume and Interface Plate)



Notes:

1. The payload container definition given here is approximate. Refer to the UP Aerospace SpaceLoft XL Mission Planner's Guide for further technical detail on the PTS-4 payload container.
2. The PTS-4 payload access opening is approximately 2.5 inches by 0.75 inches.

Figure 5-3. PTS-4 Research Payload Container Definition

5.1.2 Mass Properties

5.1.2.1 Inspirational Payloads

The mass of the Inspirational payloads shall not exceed 1.0 lb. The Inspirational payload mass includes the mass of the Inspirational payload container (Reference Figure 5-1 and Appendix D).

5.1.2.2 Research Payloads

The mass of the Research payloads shall not exceed the values given in Table 5-1. The

PL-3 Research payload mass does not include the mass of the PL-3 interface mounting plate, but does include the mass of any mechanical interface hardware (Reference Section 5.2.1.2). The PTS-4 Research payload mass does not include the mass of the PTS-4 payload container. However, as in the case of the PL-3 payloads, the PTS-4 mass allotment does include the mass of any mechanical interface hardware (Reference Section 5.2.1.2).

Table 5-1. Research Payload Allowable Masses

Payload Type	Allowable Payload Mass (lbs)
PL-3	12
PTS-4	4

5.1.3 Center of Gravity

5.1.3.1 Inspirational Payloads

The center of gravity (C.G.) for Inspirational payloads (x, y axis) shall be within 0.1 inches of the experiment payload Centerline (Reference Figure 5-1). There is no z-axis C.G. requirement for Inspirational payloads.

5.1.3.2 Research Payloads

The center of gravity (C.G.) for PL-3 Research payloads (x, y axis) shall be within 0.1 inches of the experiment payload Centerline (Reference Figure 5-2). There is no z-axis C.G. requirement for PL-3 Research payloads.

The center of gravity (C.G.) for PTS-4 Research payloads shall conform to the C.G. requirements specified in the UP Aerospace SpaceLoft XL Mission Planner's Guide.

PL-3 and PTS-4 Research payloads may satisfy the center of gravity (C.G.) requirement by either test or analysis.

5.2 Payload Interfaces

5.2.1 Mechanical Interface

5.2.1.1 Inspirational Payloads

For Inspirational payloads, the experiments are allowed to mechanically interface with the payload containers as they choose (to include no mechanical attachment, if desired). However, if mechanical attachment is selected, protrusions from the container outer mold line (OML) shown in Figure 5-1 are not allowed, and the minimal container wall thicknesses given in Section 5.1.1.1 must be maintained on the entire surface area of the container. If mechanical attachment of the Inspirational payload to the container is not utilized, then adequate packing/padding is required to protect the payload from the extreme shaking associated with the launch vehicle vibration environment.

5.2.1.2 Research Payloads

For PTS-4 payloads, the mechanical interface is to the top and/or bottom of the PTS-4 container (i.e. 0.175 inch thick bulkhead). The mechanical interface for PTS-4 Research payloads shall conform to the requirements specified in the UP Aerospace SpaceLoft XL Mission Planner's Guide. Mechanical attachment of the experiment payload to the PTS-4 container is not required. However, if mechanical attachment of the experiment payload to the container is not utilized, then adequate packing/protection is required to protect the payload from the launch vehicle vibration environment.

For PL-3 payloads, the mechanical interface is to the 0.25 inch thick aluminum plate at the aft end of the PL-3 section (Reference Figure 5-2). As is the case for the PTS-4 payloads (Reference the UP Aerospace SpaceLoft XL Mission Planner's Guide), for PL-3 payloads a minimum of four 0.25 inch diameter fasteners spaced a minimum of one inch apart should be used to mechanically attach the payload to the 0.25 inch thick aluminum mounting plate.

5.2.2 Electrical Interface

Payload electrical services under the ACCESS Program are minimal due to the fact that

the program is in the early stages of development. However, payload electrical services will be augmented over time as the ACCESS Program matures. At this time, there is no provision for experiment payload electrical services on the SpaceLoft XL launch vehicle. Experiment payloads that require electrical power are encouraged to use primary batteries with a G-switch for payload activation. In addition, a cutoff switch should be included in the design (which will be activated by personnel at the launch site) to prevent G-switch activation during shipping and handling. Experiment payloads that will be utilizing electrical power are encouraged to contact the ACCESS Program Office for up to date electrical design accommodations and requirements.

5.3 Structural Design Requirements

Experiment payloads shall be designed to withstand the flight environment without failure, causing damage to other payloads or the launch vehicle, or causing injury to the ground handling crew.

5.3.1 Materials (Recommendation)

Materials with high resistance to stress corrosion cracking (SCC) shall be used wherever possible. A list of such materials is provided in NASA MSFC-STD-3029, *Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments* (Reference Section 1.3). Use of non-metallic material shall be restricted to materials that have a maximum collectable volatile condensable material (CVCM) content of 0.1% or less and a total mass loss (TML) of 1.0% or less. Values of CVCM and TML for a wide range of materials may be found on the NASA Materials and Processes Home Page <http://ndea.jpl.nasa.gov/nasa-mp/mp-hp.htm>, and the NASA Outgassing Data for Selecting Spacecraft Materials page: <http://outgassing.nasa.gov/>.

5.3.2 Structural Loading (Recommendation)

Experiment payloads shall be designed to withstand 20 g's of quasi-static loading in each axis. These loads take into account the worst case launch load environment, which is a combination of steady state, low frequency, transient loads and high frequency vibration

loads. The load factors are in g's, and should be applied in each axis independently. Thermally induced loading, if applicable, shall be combined with the above loads. Recommended factors of safety to be used in structural design and analysis are 2.0 for yield and 2.6 for ultimate.

Payload structural analysis is recommended for Research payloads. There are no structural analysis requirements for Inspirational payloads. However, please note that the launch vehicle will experience approximately 20 g's of quasi-static loading during flight, and all experiment payloads should be designed accordingly (i.e. very robustly). Reference Section 6.2 of this document for payload structural testing requirements.

5.3.2.1 Random Vibration / Acoustic Noise (Recommendation)

The experiment payloads shall be designed to withstand the launch vehicle vibroacoustic environment without failure. The launch vehicle vibroacoustic environment is simulated through application of the vibration spectrum given in Table 5-2. Note - at this time, because the UP Aerospace SpaceLoft XL vehicle is a new vehicle, the launch vehicle vibroacoustic environment has not been characterized.

Table 5-2. Launch Vehicle Random Vibration Spectrum

TBD

5.3.2.2 Pressure Profile (Recommendation)

The SpaceLoft XL vehicle will experience the following depressurization and repressurization rates:

- Depressurization (launch vehicle ascent): 1.0 psi/sec, maximum; 0.75 psi/sec, average
- Repressurization (launch vehicle descent): 0.1 psi/sec maximum; 0.07 psi/sec, average

Venting analysis is not required for ACCESS Program payloads. A vacuum test is recommended for Inspirational payloads, and required for Research payloads (Reference Section 6.4).

5.3.2.3 Shock Environment (Recommendation)

Experiment payloads will experience significant shock events when the rocket launches, when the recovery parachute deploys, and when the payload section returns to Earth and contacts the ground (which is expected to be the most severe shock event that the payloads experience). Under recovery parachutes, the velocity of the payload section of the SpaceLoft XL vehicle at touchdown is nominally 30 ft/sec. The shock environment at vehicle touchdown is estimated to be 60 g's for 0.25 seconds.

5.3.2.4 Pressurized / Sealed Systems

Pressure vessels (to include un-vented containers) and pressurized components must be approved by the ACCESS Program Coordinator prior to their use. A complete description of all proposed pressure vessels / systems (including diagrams, drawings and complete system descriptions) must be submitted to the ACCESS Program Coordinator for approval prior to their use.

5.4 Cleanliness (Recommendation)

All experiment payload flight hardware shall be maintained at the Visibly Clean (VC) level, per KSC-C-123H, *Specification for Surface Cleanliness of Fluid Systems* (Reference Section 1.3). This entails no visible surface contamination from an observer distance of 6-18 inches under 100 ft-candle illumination, with the payload maintained in a class 100,000 environment or better. Note that the exterior of both the Inspirational Payload and PTS-4 containers will be cleaned to a VC level by ACCESS Program Personnel prior to integration with the launch vehicle.

5.5 Thermal Design Requirements

Experiment payloads shall be designed to withstand the pre-launch, in-flight, as well as post-launch thermal environments given in this section without failure or resulting in a hazardous condition. Note that the controlling (i.e. extreme) temperatures are the pre and

post launch values.

In-flight launch vehicle thermal environment (maximum range): 50° F – 150° F.

In-flight launch vehicle thermal environment (expected range): 80° F – 120° F.

Pre/post launch thermal environment (maximum range): 32° F – 200° F.

5.6 Electromagnetic Interference / Electromagnetic Compatibility (Recommendation)

For experiment payloads with electronic components, electromagnetic interference (EMI) from outside sources will be mitigated by an aluminum enclosure. In the case of the Inspirational payloads and the PTS-4 Research payloads, this is accomplished by their respective aluminum payload containers. However, EMI shielding will be required on all container holes and/or seams to maintain proper EMI protection. For the PL-3 Research payloads, the payload volume is enclosed by the aluminum skin section of the rocket.

All experiment payloads that contain electronic components will need to design for electromagnetic self-compatibility, which is the primary EMI/EMC concern. Organizations with electronic components in their payload should perform frequent electromagnetic self compatibility tests (i.e. power on and operate the experiment hardware in the physical and functional flight configuration) throughout their payload development.

While EMI/EMC analysis/testing is a complex discipline, the frequent electromagnetic self compatibility testing recommended above should ensure proper payload function in flight, and represents the only practical testing and/or analysis that can be accomplished by most payload organizations. Further questions and/or clarifications on EMI/EMC design and testing considerations should be directed to the ACCESS Program Office.

5.7 General Design Guidance (Recommendation)

Tables 5-3 and 5-4 provide guidance for design approaches and practices that facilitate payload mission success. Guidance is compiled from lessons learned on previous space experiment programs. Therefore, payload organizations should make a serious effort to follow these guidelines.

Table 5-3. Design Guidance: Encouraged Practices

Encouraged Designs/Practices
1. Use machined aluminum (Al 6061) primary support structure.
2. Use threaded fasteners with backout protection for joining components and assemblies. Locking nuts, helicoils and lock wires are the preferred means of backout protection. Socket head cap screws (SHCS) are the preferred threaded fasteners.
3. Use multiple fasteners for joining components such that failure of one fastener will not cause a structural or mechanical failure, or release of a part.
4. Design payload structures with redundant load paths, built from machined metals with well-understood properties (i.e. aluminum), and having low stresses.
5. When purchasing hardware, especially components that contain non-metallic items, obtain a materials list first and, if dictated by payload requirements, ensure that all materials meet the outgassing requirements - Reference Section 5.3.1. Obtain certificates of compliance (C of C's) for all purchased flight hardware.
6. The use of glass should be minimized. Where glass must be used, it should be non-pressurized and subject only to inertial loading.
7. All electronics should be housed in EMI-shielded enclosures. In general, the payload containers provide this function for the payloads from outside EMI/EMC sources. Wire harnesses should be appropriately shielded and/or terminated.

Table 5-4. Design Guidance: Discouraged Practices

Discouraged Designs/Practices
1. Use of composite primary structure including traditional non-metallic composite structures, metallic structure built up using adhesives, and bending as a means of forming metallic primary structures.

Discouraged Designs/Practices
2. Use of epoxies, adhesives, or tape to join structural components, particularly in the primary structure / load path; or for components that could break loose from the payload if the adhesive/tape were to fail.
3. Use of cables, lines, cords, tie straps / zip ties, plastic parts, or other non-metallic “soft goods” in the primary structure, or in instances where a failure of that part could result in a hazardous situation.
4. Use of pressure vessels or toxic and/or volatile fluids or gasses is prohibited except with prior written approval from the ACCESS Program Coordinator.

6. PAYLOAD TEST REQUIREMENTS

Experiment payloads are responsible for payload testing as shown in Table 6-1. Note that the payload testing requirements given in Table 6-1 vary significantly by payload type. In general, all environmental testing should occur in the flight configuration. Once the payload has been environmentally tested, it is strongly recommended that the configuration not be broken or modified, as this could invalidate the objective of the testing. Great care should be exercised in the course of all payload environmental testing to both ensure personnel safety and protect the payload from inadvertent damage due to accidents or over-test conditions.

Table 6-1. Experiment Payload Environmental Test Requirements

Environment / Test (Reference Section)	Payload Type	
	Inspirational	Research
Payload Mass / Calibrated Scale (Section 6.1)	Required	Required
Payload CG (Section 6.1)	Optional	Recommended
Payload Physical Envelope ¹ (Section 6.1)	Required	Required

Environment / Test (Reference Section)	Payload Type	
	Inspirational	Research
Structural Strength / Whip Test (Section 6.2)	Optional	Recommended
Random Vibration and Acoustic Noise (Section 6.3)	Optional	Recommended
Pressure Profile / Vacuum Test (Section 6.4)	Recommended	Required
Shock / Drop Test (Section 6.5)	Optional	Recommended
Thermal / Oven - Cooler Test (Section 6.6)	Recommended	Required
EMI/EMC Self Compatibility / Functional Test (Section 6.7)	Required ²	Required ²
Electrical System Aliveness and Functional Tests ³ (Section 6.8)	Required ²	Required ²

Notes for Table 6-1:

1. Payloads must fit freely within their payload container. Forcing of the payload into the container, thus creating pre-stressing in the container and/or the experiment support structure, is prohibited.
2. If the payload contains electronic components.
3. For payloads that contain electrical components, electrical system aliveness and functional testing must be completed at the conclusion of environmental testing to ensure payload functionality prior to payload shipment for integration to the launch vehicle.

6.1 Payload Mass / C.G. / Physical Envelope

Experiment payload organizations are responsible for verifying that the payload falls within the mass and C.G. constraints specified in Sections 5.1.2 and 5.1.3. Verification of the total payload mass shall be conducted using a calibrated scale accurate to 0.1 lb. or better. Verification of the payload mass is required for both Inspirational payloads and Research payloads. Verification of the payload C.G. is optional for Inspirational payloads and recommended for Research payloads. Verification of payload C.G. can be accomplished by either analysis or test.

In addition, as specified in Section 5.1.1, Inspirational and PTS-4 Research payloads must fit completely and freely within their payload containers. Forcing of the experiment payload into its payload container, thus pre-stressing the payload container and/or experiment components, is prohibited. Verification of the payload physical envelope / volume is required for both Inspirational payloads and Research payloads.

6.2 Structural Strength / Whip Test

Verification of the structural strength of the experiment payload may be accomplished via a whip test. As with all environmental testing, personnel safety is the primary concern – whip testing should not be attempted unless it can be accomplished in a safe manner. The whip test consists of attaching a 2 ft. rope/cable securely to the payload container and rotating the payload at 2.8 revolutions per second for a duration of approximately 1 minute. This test simulates the 20g payload loading of launch vehicle ascent. Alternatively, application of the 20g loading can be accomplished via a sine burst test on a shaker table. Verification of the payload structural strength is optional for Inspirational payloads and recommended for Research payloads.

6.3 Random Vibration / Acoustic Noise

Experiment payload organizations shall conduct a random vibration test to verify payload workmanship and the ability of the payload to withstand the launch vehicle vibroacoustic environment without failure. The random vibration test consists of attaching the payload securely to a shaker table and applying the random vibration / acoustic noise spectrum given in Section 5.3.2.1 (note – at this time, the launch vehicle random vibration environment has not been characterized). Random vibration testing is optional for Inspirational payloads and recommended for Research payloads.

6.4 Pressure Profile / Vacuum Test

Experiment payload organizations shall conduct a vacuum test to verify the ability of the payload to withstand the depressurization of launch vehicle ascent, the vacuum of space,

and the repressurization of launch vehicle descent. The vacuum test consists of placing the payload in a vacuum device, which can be as simple as a *clean* Seal a Meal® or FoodSaver® food preparation vacuum container. Once the payload is placed in the vacuum device, the vacuum shall be engaged and held for approximately 15 minutes. If the vacuum device is capable of it, the depressurization and repressurization rates given in Section 5.3.2.2 can be implemented during the vacuum test. Vacuum testing is recommended for Inspirational payloads and required for Research payloads.

6.5 Shock / Drop Test

Experiment payload organizations may conduct a drop test to verify the ability of the payload to withstand the launch vehicle payload section touchdown shock event. As with all environmental testing, personnel safety is the primary concern – drop testing should not be attempted unless it can be accomplished in a safe manner. The shock test consists of dropping the payload from 15 ft to a hard surface (i.e. compacted soil). Use of a substitute payload container is required for this testing – the flight payload container ***shall not*** be used during this testing. Alternatively, application of the shock loading given in Section 5.3.2.3 can be accomplished via a shock test on a shaker table. Drop / shock testing is optional for Inspirational payloads and recommended for Research payloads.

6.6 Thermal / Oven – Cooler Test

Experiment payload organizations shall conduct an oven / cooler test to verify payload survivability at the expected thermal extremes. For the oven test, the payload shall be soaked in an oven (can be a *clean* commercial or residential oven) at 200° F for 1 hour. The payload should be bagged using a high-temperature bagging material (e.g. Reynolds® Oven Bags) to further prevent contamination from the oven. At the conclusion of the oven test, the payload shall be thoroughly cleaned using denatured alcohol and clean room wipes (e.g. Kim Wipes). For the cooler test, the payload shall be placed in a cooler for 1 hour with a sufficient quantity of block ice to maintain the interior cooler temperature at approximately 32° F. At the conclusion of both the oven and cooler tests, the experiment payload shall be physically inspected to ensure that no damage occurred during the testing and functionally

tested to insure proper payload functionality. Thermal testing is recommended for Inspirational payloads and required for Research payloads.

6.7 EMI/EMC Self Compatibility / Functional Test

Experiment payloads that contain electronics shall conduct regular functional tests throughout payload build to verify payload electromagnetic self compatibility (i.e. proper payload functionality in the presence of potential payload electromagnetic interference sources). While this is not a perfect EMI/EMC functionality test, it does represent an appropriate middle ground given the limitations of most payload organizations participating in the ACCESS Program. During functional tests, the payload should be in as close to the flight configuration as possible (i.e. in the experiment payload container, or a suitable simulator, with all major components physically and functionally represented). For PL-3 Research payloads, housing the payload in a metal container which is nominally 12 inches in diameter by 12 inches tall should provide an adequate EMI test environment. EMI/EMC self compatibility testing is required for all Inspirational and Research payloads that contain electronics.

6.8 Electrical System Aliveness and Functional Tests

Experiment payloads that contain electronics shall conduct regular (i.e. throughout payload build) and final pre-ship functional tests to verify payload functionality. Electrical system aliveness / functional testing is required for all Inspirational and Research payloads that contain electronics.

6.9 Pre and Post Delivery Testing

Prior to and after delivery to the ACCESS for Education Program for launch, the experiment payload shall be tested as follows:

- If applicable, verify that payload safety features are in place and functional.
- If applicable, verify that payload functions properly with regard to mission success.

- Verify that payload ground test and maintenance operations can be performed safely.

6.10 Environmental Testing Summary

Each experiment payload organization shall submit a summary (including pictures) of the results of their environmental testing as part of the payload flight ready data submittal (Reference Appendix B).

7. ACRONYMS

Acronym	Title
CAD	Computer Aided Design
CAM	Computer Aided Machining
CG	Center of Gravity
CPS	Cycles per Second
CVCM	Collectable Volatile Condensable Material
ITAR	International Traffic in Arms Regulations
EGSE	Electrical Ground Support Equipment
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
FRDS	Flight Ready Data Submittal
FS	Factor of Safety
GSE	Ground Support Equipment
LV	Launch Vehicle
MGSE	Mechanical Ground Support Equipment
MS	Margin of Safety
OML	Outer Mold Line
POC	Point of Contact
RF	Radio Frequency
SCC	Stress Corrosion Cracking
SHCS	Socket Head Cap Screw
TBD	To Be Determined
TML	Total Mass Loss
UPS	United Parcel Service
VC	Visibly Clean

APPENDIX A - TECHNOLOGY AREAS OF INTEREST

The following is a list of experiment payload technologies of interest to the ACCESS for Education Foundation and Microgravity Enterprises, Inc. As was mentioned previously, one of the primary goals of the ACCESS for Education Program is to implement and foster space education and commercialization activities through a national hands-on space experiment flight program. As such, preference will be given in the ACCESS Program to Research payloads that are based on space commercialization research and development. This focus is reflected in the technology list that follows. In addition, because the UP Aerospace SpaceLoft XL launch vehicle - the baseline for all Microgravity Enterprises Phase 1 commercial suborbital flights – is a new vehicle, the vehicle environments presented in this document represent best estimate enveloping environments. Early Phase 1 ACCESS experiment payloads are encouraged to fly sensor packages to provide actual flight environments for both future ACCESS payloads and Microgravity Enterprises commercial payloads. Refer to the ACCESS for Education (www.ACCESSforEducation.org), and Microgravity Enterprises, Inc. (www.MicrogravityEnterprises.com) websites for background material and further information on these topics.

Phase 1: Suborbital Flights

1. Launch Vehicle Environment Characterization
 - a. Temperature
 - b. Pressure
 - c. Noise (i.e. sound level)
 - d. Inertial Loading
 - i. Quasi-static
 - ii. Shock
 - iii. Random Vibration
2. Pharmaceutical Products (quality, yield and cost improvements)
3. Nanomaterial Bonding and Formulations

4. Crystal Growth
5. Plant Yield and Variability (with a focus on food products)
6. Biotechnology Development and Testing
7. Advanced Materials Development
8. Other Space Commercialization Research and Development Payloads

Phase 2: Orbital Payload Return Flights

1. Pharmaceutical Products (quality, yield and cost improvements)
2. Nanomaterial Bonding and Formulations
3. Crystal Growth
4. Plant Yield and Variability (with a focus on food products)
5. Biotechnology Development and Testing
6. Advanced Materials Development
7. Energy Harvesting
8. Other Space Commercialization Research and Development Payloads

The above listing should not be considered an exhaustive list of potential payload topics. Payload organizations are encouraged to propose innovative commercial space research and development payloads not listed above.

APPENDIX B - EXPERIMENT PAYLOAD DATA SUBMITTALS

Experiment payload organizations are required to submit the following documentation packages under the ACCESS for Education Program:

1. Entry Form – the entry form should be completed as soon as the payload organization feels that they are sufficiently mature as a program to commit to the ACCESS Program. Only one entry form per educational institution is allowed at one time. The Entry Form should be updated and resubmitted by the payload organization as appropriate as the experiment matures. It is imperative that the contact information on the Entry Form be kept up to date, as this will be the means by which the ACCESS Program Office will contact the payload organizations for upcoming flight opportunities. Note - the Entry Form can be found in the “Program Forms and Documents” section of the ACCESS for Education Program website, and as Appendix C of this document.
2. Flight Ready Data Submittal (FRDS) – the flight ready data submittal will be used to determine acceptance to the payload manifests. Flight ready data submittals should not be made until the experiment payload is sufficiently mature to guarantee delivery of the experiment payload at any point after T+60 days from the FRDS submittal. Flight ready data submittals should be e-mailed to info@ACCESSforEducation.org. After submission, the flight ready data submittal will be reviewed by the ACCESS Program Coordinator, and either returned to the experiment organization with required improvements and/or edits noted; or the flight ready data submittal will be accepted and the experiment payload added to the appropriate Flight Manifest. Experiment payload organizations are required to submit the following documentation in their Flight Ready Data Submittal:

Inspirational Payloads (~5 pages total, age appropriate level of detail):

- Summary of experiment payload goals and objectives, and how the proposed experiment meets those goals and objectives.
- Picture based summary of experiment payload, including payload views, build process, and environmental testing (if applicable).

- Materials list – a complete listing of all materials contained in the experiment payload.
- Results of environmental and/or functional testing (if applicable).

Research Payloads (~10-20 pages total):

- Summary of experiment payload research goals and objectives, and how the proposed experiment meets those goals and objectives.
 - Clearly indicate if the payload will be utilizing the PL-3 or PTS-4 payload allotment.
 - Picture based summary of experiment payload, including payload views, build process, and environmental testing.
 - Materials list – a complete listing of all materials contained in the experiment payload, including soft goods (e.g. epoxies, tapes, adhesives, etc.), coatings (i.e. anodize, plating, conformal coating, etc.) and vendor purchased equipment.
 - Results of environmental and (if applicable) functional testing.
3. Post-flight Experiment Results – All experiment payloads are expected to provide, at minimum, a summary briefing or paper of their space flight experiment results to the ACCESS Program Office within 90 days of completion of the space flight experiment. Payload organizations will not be allowed to enter future experiment payloads into the ACCESS for Education Program until this requirement is met.

APPENDIX C - ACCESS PROGRAM ENTRY FORM

E-mail completed form to info@ACCESSforEducation.org

Payload Type: Inspirational / Research

Entry Type: New / Update

General Information

Payload/Program Name:

Educational Institution:

Address 1:

Address 2:

City:

State:

Zip Code:

Educational Institution/Payload website (if applicable):

Primary Point of Contact

First Name:

Last Name:

Program Title:

Primary Email:

Secondary Email (if applicable):

Work Phone Number (with area code):

Fax Number (with area code):

Mobile Phone Number (with area code) (if applicable):

Alternate Point of Contact

First Name:

Last Name:

Program Title:

Primary Email:

Secondary Email (if applicable):

Work Phone Number (with area code):

Fax Number (with area code):

Mobile Phone Number (with area code) (if applicable):

Program / Payload Description

In two pages or less, describe the proposed experiment, including experiment objectives, top level payload details, and program organizational structure.

APPENDIX D - RECOMMENDED INSPIRATIONAL PAYLOAD CONTAINER DESIGN DRAWINGS

It is strongly recommended that Inspirational Payloads use the payload container design given in Figures D-1 through D-3. The ACCESS Program Office has a small quantity of containers of this design on hand for use in the ACCESS Program. Contact the ACCESS Program Office to determine current availability.

In addition, solid files of the recommended Inspirational payload container parts shown in Figures D-2 and D-3 are available for download from the “Program Forms and Documents” section of the ACCESS for Education Program website. These files are suitable for import directly into a standard computer aided machining (CAM) package.

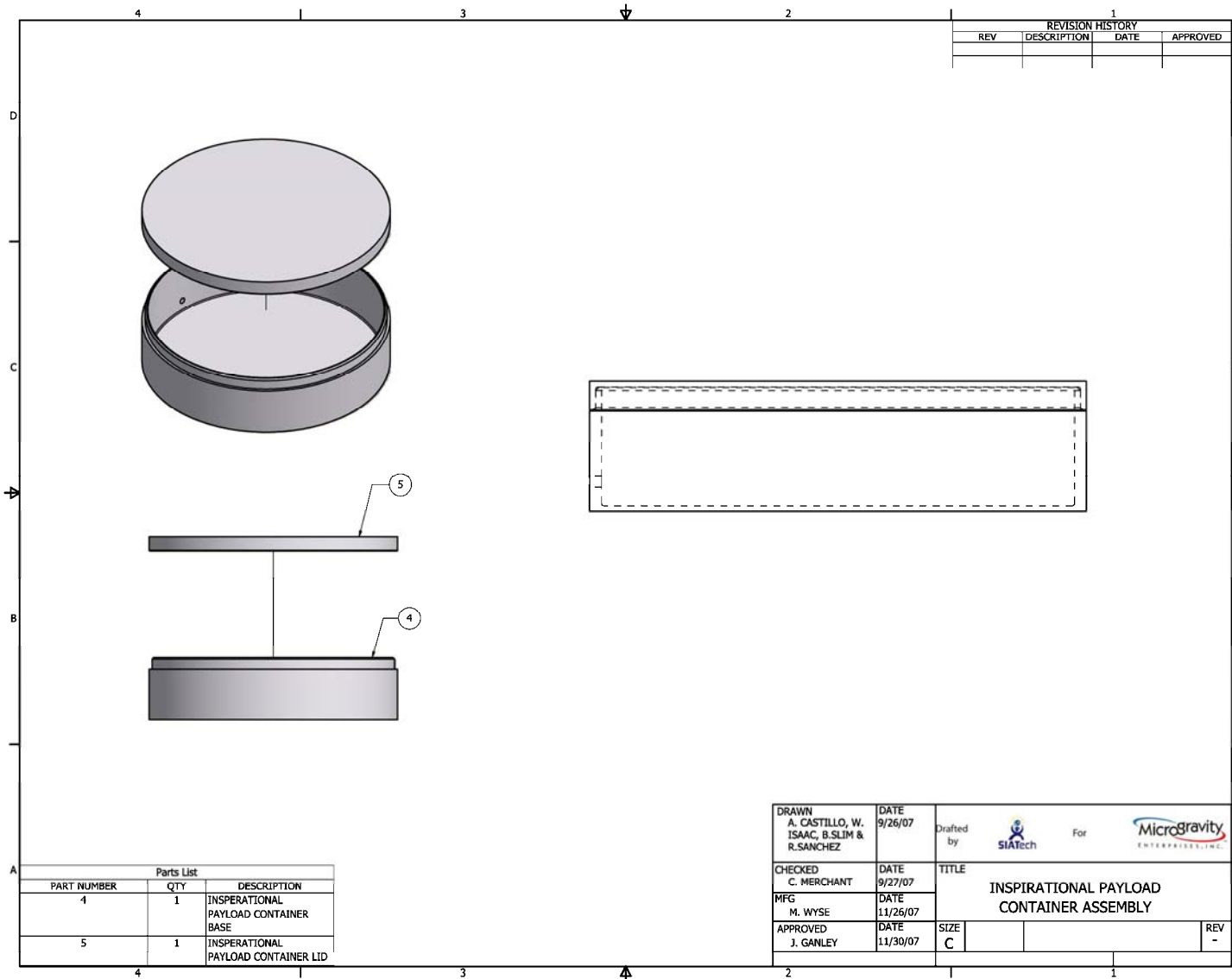


Figure D-1. Recommended Inspirational Payload Container Assembly Drawing

Note – the mass of this container = 0.26 lbs (118.5 grams).

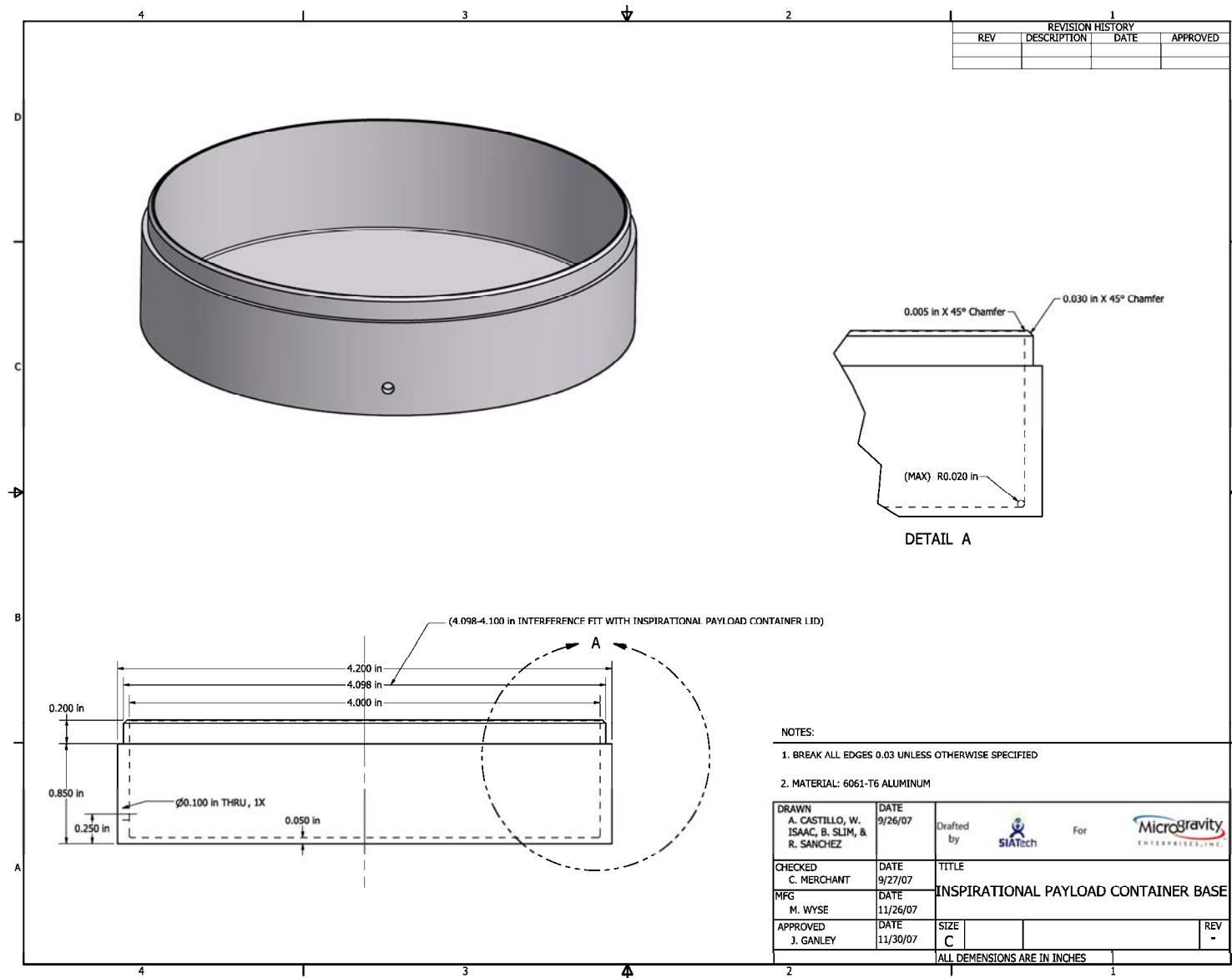


Figure D-2. Recommended Inspirational Payload Container Base Drawing

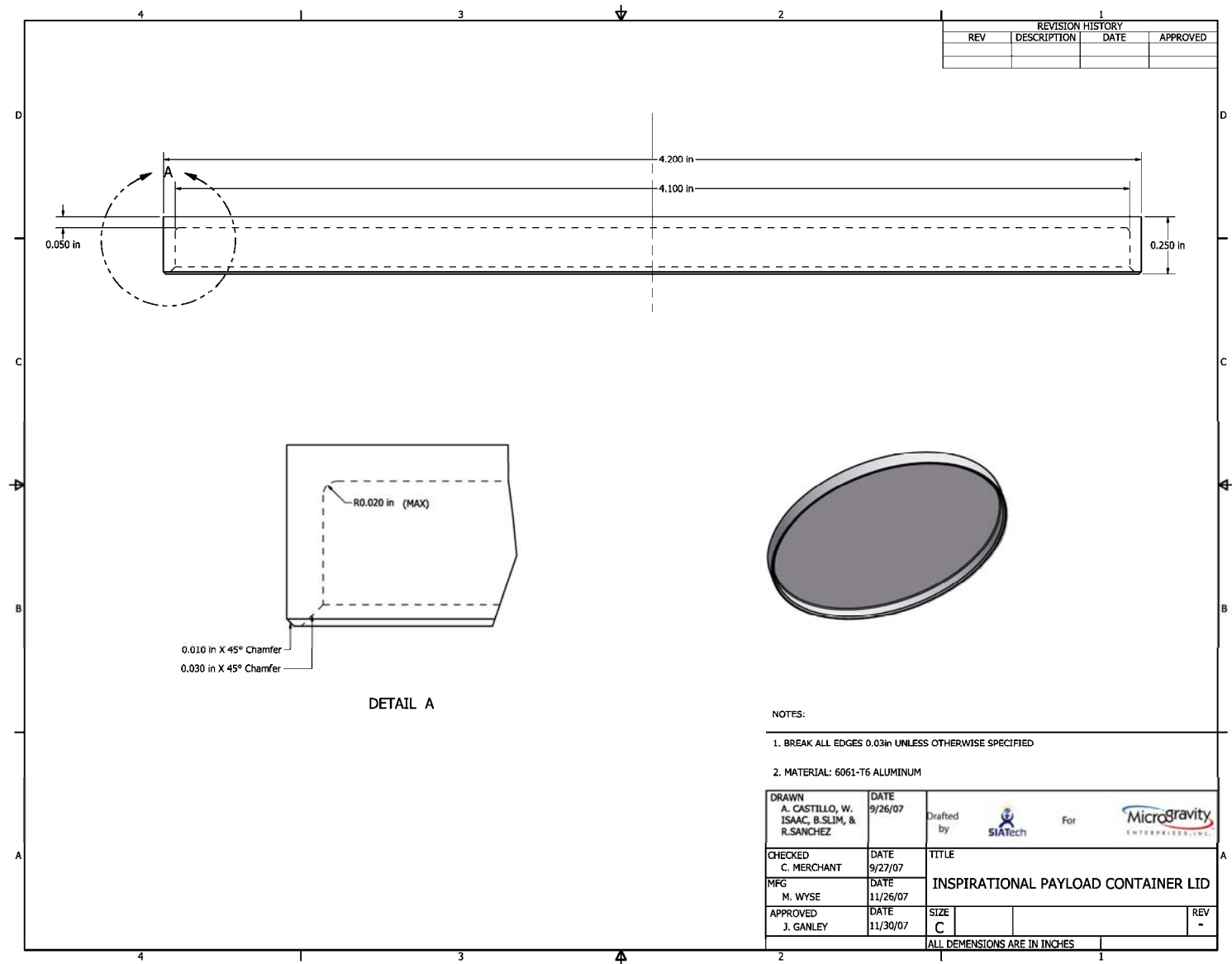


Figure D-3. Recommended Inspirational Payload Container Lid Drawing