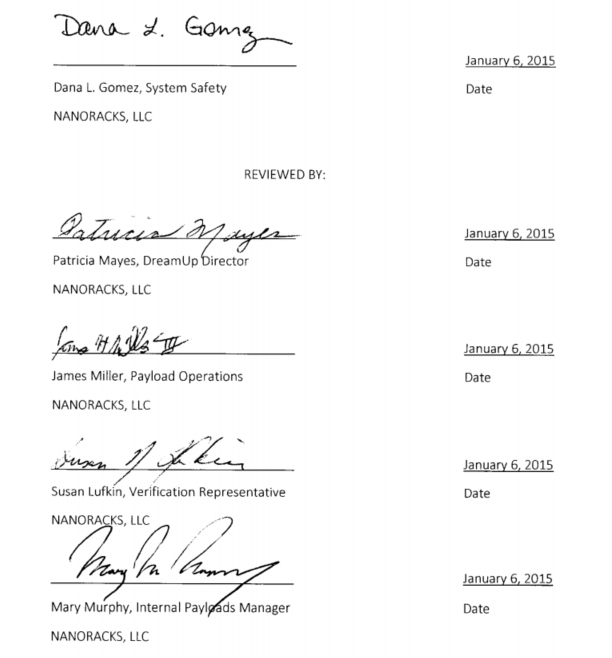
|  |
| --- |
|  |
| NanoRacks  Safety Data Template (SDT) for  Intra-Vehicular Activity (IVA) Payloads Interfacing with NanoRacks Platform-1A/-2A |
|  |
| NanoRacks, LLC  555 Forge River Road, Suite 120  Webster, TX 77598  (815) 425-8553  [www.NanoRacks.com](http://www.NanoRacks.com/) |
|  |
|  |
|  |

**NanoRacks Safety Data Template (SDT) for IntraVehicular Activity (IVA) Payloads Interfacing with NanoRacks Platform-1A/-2A**

PREPARED BY:



REVISION AND HISTORY PAGE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Status | Revision No. | Change  No. | Description | Release Date |
| Baseline | -- | -- | Baseline | 01/06/2015 |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  | | | | |

Table of Contents

Acronyms 6

1 Introduction 7

2 Project Description 7

2.1 Concept of Operations and Timeline 7

2.2 Preparation Time 8

3 Detailed System Description 8

3.1 System Description 8

3.2 Structure 8

3.2.1 Dimensions and Mass Properties 8

3.2.2 Vent Area Assessment 9

3.2.3 Fastener Backout Prevention (Secondary Locking Feature) 9

3.3 Power 9

3.3.1 Electrical System 9

3.3.1.1 Electrical Interface to NanoRacks Platform-1A/-2A 9

3.3.1.2 Electrical System Schematics 10

3.3.1.3 Battery Flight Acceptance Tests 11

3.4 Communications 11

3.4.1 Downlink System 11

3.5 Components 11

3.5.1 Rotating Equipment 11

3.5.2 Pressure Systems 12

3.5.3 Magnetic Devices 12

3.6 Thermal 13

3.6.1 Thermal Control System 13

3.7 Materials Assessment 13

3.7.1 Liquids/Gasses/Biologicals/Chemicals 13

3.7.2 Frangible Materials 13

3.8 Bill of Materials 14

4 Integration 14

4.1 Stowage Requirements 14

5 Environmental Testing 15

5.1 Random Vibration Testing 15

5.2 Pre-delivery Mechanical Compatibility Check (Fit Check) and Functional Test 15

6 Additional Requirements 16

Appendix A – NASA Interpretation Letter TA-92-038 17

Appendix B – Event Guidelines for Determining a Payload’s Timeline 18

Appendix C – Switch Protection Requirements 21

# Acronyms

|  |  |
| --- | --- |
| BOM | Bill of Materials |
| CDC | Center for Disease Control |
| COTS | Commercial-Off-The-Shelf |
| IVA | Intra-Vehicular Activity |
| MDP | Maximum Design Pressure |
| MOP | Maximum Operating Pressure |
| MSDS | Material Safety Data Sheet |
| NR | NanoRacks |
| SDT | Safety Data Template |
| SOW | Statement of Work |

# Introduction

General NanoRacks Safety Data Template (SDT) for Intra-Vehicular Activity (IVA) Payloads.

This template is intended to be used with the NanoRacks Customer Portal at customer.nanoracks.com (no www or http prefix). Customers are issued a portal account by the NanoRacks Customer Service representative. Customers should insert requested data directly into the template where appropriate. Large schematics, native CAD files, or other content not easily inserted into the template may be uploaded into the Customer Portal Repository. In such case insert the filename uploaded to the Repository into the appropriate template field.

# Project Description

Provide the following information:

|  |  |
| --- | --- |
| Project Sponsor |  |
| Project Manager |  |
| Point of Contact |  |
| Mission Overview |  |

## Concept of Operations and Timeline

Provide a brief timeline describing major events associated with pre-flight, in-flight and post-flight activities (including ground operations at NanoRacks and/or launch-site facilities, launch, transfer/installation, activation, on-orbit operations, destow and return or trash).

|  |  |
| --- | --- |
| **Time (weeks/days/minutes)** | **Event** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Use "Event Guidelines" in Appendix A to plan payload times within the constraints of the vehicle/ISS Program capabilities. Also use these guidelines to answer the life limit of your experiment.

If Applicable, provide life limits on science -- otherwise note "N/A":

- How long from turn-over to NanoRacks will samples be viable under ambient and cold stow conditions?  
- Will a secondary set be provided for refresh of the payload for a flight scrub situation? If yes, how soon will refresh be available?

## Preparation Time

1. How long does it take to load your experiment?
2. How long does it take to refresh your experiment?
3. How long are your samples good for before they need to be activated?

# Detailed System Description

## System Description

Provide the following:

|  |  |
| --- | --- |
| **Major Systems Block Diagrams** | |
| Structure |  |
| Power (including USB, cable, batteries and capacitors) |  |
| Communications (Data and/or Command) |  |
| Components (Pumps, motors, electromagnets, LEDs, etc.) |  |
| Thermal (fans, heaters, etc.) |  |
| Materials including liquids/gasses/biologicals |  |

## Structure

### Dimensions and Mass Properties

Provide the following:

|  |  |
| --- | --- |
| **CAD File(s)** | |
| Payload CAD file. File format in order of preference SW2012, Parasolid or STEP format. |  |
| **Exterior View Drawing** | |
| +/- X face drawing, dimensions annotated |  |
| +/- Y face drawing, dimensions annotated | |
| +/- Z face drawing, dimensions annotated |  |
| **Internal System** | |
| Detailed drawing(s) showing component/system layout |  |
| **Mass Properties** | |
| Total Mass (kg), Design |  |
| Total Mass (kg), As-built |  |
| **As-built Dimensions (mm)** | |
|  |  |
|  |  |
|  |  |
|  |  |

### Vent Area Assessment

|  |  |
| --- | --- |
| **Vent Area Assessment** | |
| Effective volume [NanoRacks will determine from provided CAD and physical data) |  |
| Total Unobstructed vent area mm2 (i.e. estimated gap area of components that permit venting) |  |

### Fastener Backout Prevention (Secondary Locking Feature)

A secondary locking feature is required for fasteners external to the Payload Container that will not be held captive by the spacecraft structure and enclosure should it come loose.

NOTE: The use of lockwire or locking compounds must be approved by NanoRacks. Self-priming liquid-locking compounds are not approved.

|  |  |
| --- | --- |
| **Secondary Locking Feature Data** | |
| Backout prevention type (helicoil insert, locking compound, etc.) |  |
| Loctite primer # |  |
| Loctite liquid-locking compound # |  |
| Statement secondary locking compound used in accordance with NanoRacks approved procedure (provided to Customer) |  |

## Power

### Electrical System

#### Electrical Interface to NanoRacks Platform-1A/-2A

The NanoRacks Platform-1A/-2A provides USB Type B connections for 5VDC/2W (500 mA) power to the modules.

The 5 VDC USB power is specified according to the USB 2.0 High Power standard, allowing a maximum current draw of 500 mA.

Minimum wire sizing internal to the payload must be 26 AWG for a maximum current of 5.3A in the cabin, using 200 Deg C wire rating in accordance with NASA Interpretation Letter TA-92-038 (See Appendix A).

If an extra cable is planned for use on-orbit for data or power, the payload developer must confer with NanoRacks for proper cable design requirements. Detailed drawings must be provided to NanoRacks prior to incorporation of the cable into the design for NanoRacks approval.

Grounding and bonding is required for all powered modules. For aluminum cubes, the payload developer shall strip all faying surfaces to ensure all panels/screws make contact. A single point ground shall be implemented from cube to the USB connector shell. For grounding/bonding the resistance shall measure less than 0.1 Ohm. If there are questions regarding grounding/bonding, contact NanoRacks for assistance.

#### Electrical System Schematics

Please provide the following:

|  |  |  |
| --- | --- | --- |
| **Electrical System Schematics** | | |
| Overall electrical system functional schematic | |  |
| Diagram showing voltage, wire sizing, grounding and circuit protection, etc. | |  |
| Battery configuration schematic | |  |
| Real-time electronics and battery schematic | |  |
| **Electrical Power System Board** | | |
| Manufacturer |  | |
| Model or part no. |  | |
| Electrical Power System Board Schematic |  | |

The payload developer shall inform NanoRacks of any batteries or capacitors to be used in the payload design as soon as possible in order to initiate the certification process. Some batteries may or may not be used. This is determined on a case by case basis; the use or potential use of all batteries is coordinated with the NASA Battery group for approval.

|  |  |
| --- | --- |
| **Main Power Batteries** | |
| Manufacturer |  |
| Model or part no. |  |
| Number of Packs |  |
| Number of Cells |  |
| Battery cell type/chemistry |  |
| Cell dimension and mass |  |
| Previous flight history of battery/cells if applicable. |  |
| Specify cell casing type (i.e. “hard” or “pouch”) |  |
| **Coin or button cells** | |
| Manufacturer |  |
| Model or part no. |  |
| Number of cells |  |
| Schematic |  |
| **Battery charging system** | |
| Battery charging system schematic |  |
| **Battery protection system** | |
| Battery protection circuit schematic |  |

|  |  |
| --- | --- |
| **Other power systems** | |
| Energy storage devices, e.g. capacitors (including quantity, datasheets, etc.), etc. |  |

CONFIRM (YES/NO) THAT THE PAYLOAD CIRCUITRY IS NOT POWERED DURING FLIGHT (if it has a battery for real-time clock only, answer NO still):

What impacts would an interruption to NanoRacks facility power have on the payload (i.e. power recycle due to ExPRESS Rack issues, or stop/start for other payload installations)? (Please include the max time length of an interruption you think your payload can tolerate without loss of science.)

#### Battery Flight Acceptance Tests

1. Battery testing conducted according to NanoRacks provided statement of work (SOW) available on the NanoRacks Customer Portal.

|  |  |
| --- | --- |
| **Flight Battery Testing** | |
| Main flight batteries |  |
| Coin or button cells |  |

## Communications

### Downlink System

Provide the following:

|  |  |
| --- | --- |
| **Downlink System** | |
| Data to downlink (e.g. video, data, environmental data, etc. Also provide file format and anticipated file size) |  |
| Downlink schedule (e.g. weekly, 3 days a week, bi-weekly every other week, etc.) |  |

## Components

Describe all payload components and their functions in detail including manufacturer and part number. Feel free to add more information than necessary – more is better. Include figures or illustrations to show the payload configuration and layout in detail.

### Rotating Equipment

Provide detailed description of fans, motors, pumps, etc.

|  |  |
| --- | --- |
| **Rotating Equipment** | |
| Type – fan, motor, pump, etc. |  |
| Manufacturer |  |
| Part Number |  |
| Maximum RPM |  |
| Containment |  |
| Dimensions |  |
| Datasheet |  |
| Motor type – DC motor, stepper motor, eccentric motor, etc. |  |
| Magnet(s)? |  |
| Brushless motor? |  |
| Fans |  |
| Locked rotor protection? |  |
| Magnet(s)? |  |

Are any switches involved? If “YES”, describe and confirm what switch protection design from Appendix C is utilized.

### Pressure Systems

|  |  |
| --- | --- |
| **Pressure Systems** | |
| Overall description to include maximum design pressure (MDP), maximum operating pressure (MOP), detailed design description |  |
| Containment description (e.g. pressure vessel, composite dewar, etc.) |  |
| Pressure levels |  |
| Detailed schematic |  |
| Pressurant |  |

### Magnetic Devices

If permanent/electro-magnets used:

|  |  |
| --- | --- |
| **Magnet Description** | |
| Number permanent/electro-magnets |  |
| Schematic depicting physical layout within Payload |  |
| Manufacturer |  |
| Model or part no. |  |
| If permanent magnets, list field strength (Gauss) per each Module up to 3 cm away  (If measurement is greater than 1 Gauss at 3 cm, at what point does it reach 1 Gauss?) |  |
| If electro-magnets, list field strength per each (amps-turns-m2) |  |

## Thermal

### Thermal Control System

|  |  |
| --- | --- |
| **Thermal Control Systems** | |
| Overall description and operation |  |
| Heaters |  |
| Maximum temperature when operating nominally |  |
| Maximum failed-on temperatures |  |
| Detailed system schematic |  |

## Materials Assessment

### Liquids/Gasses/Biologicals/Chemicals

List all liquids, gasses, biologicals or chemicals regardless of the volume/amount; include the maximum concentration, maximum volume or amount, and its hazard number (on the MSDS or CDC) associated with it. Include MSDS sheet for each material.

|  |  |
| --- | --- |
| **Liquids/Gasses/Biologicals/Chemicals** | |
| Identify materials, their type, location, quantity/volume and concentration |  |
| Identify toxic materials containment method  (enclosed area or encapsulation) |  |
| Detailed schematics/engineering drawings/models of containment levels |  |
| Intended method for verifying each level of containment individually  (once complete, summary of verification measures and results required to be provided to NanoRacks) |  |
| If seeds, plants or bugs, etc., certificate of conformance from the supplier is required for assurance that the seeds and bugs, etc. are harvested/grown/raised in a controlled environment with no cross contamination, pesticides, herbicides, etc. used. |  |

### Frangible Materials

Try to avoid using glass if at all possible. If it cannot be avoided, such as use of an internal microscope lens or another brittle/fragile material, describe it in the table below:

|  |  |
| --- | --- |
| **Frangible Materials** | |
| Identify materials, their type and location |  |
| Identify materials containment method  (enclosed area or encapsulation) |  |
| Detailed schematics/engineering drawings/models |  |

## Bill of Materials

A bill of materials (BOM) broken down to the component level or part level is acceptable. Include all manufacturers and part numbers.

|  |  |
| --- | --- |
| **Bill of Materials** | |
| All metallic and nonmetallic components with dimensional measurements |  |
| Electrical components with dimensional measurements |  |
| Lubricants, adhesives, coatings, glass, plastics with volume/amount/dimensional measurements used |  |
| System level components (COTS items like pumps, motors, etc.) with dimensional measurements |  |

# Integration

Customers must provide a letter describing their integration requirements. The letter, at a minimum, must contain:

|  |  |
| --- | --- |
| **Customer Integration Letter** | |
| Location |  |
| Mounting hardware (if applicable) (NOTE: If using a NanoRacks Module, state “STANDARD USE”) |  |
| Secondary locking feature |  |
| Stowage orientation requirements during transport (if any, provide diagrams) |  |

NOTE: thermal control is not available during operations within a NanoRacks Platform; however, up/down and pre-/post-ops can be requested (approval depends on vehicle/thermal facility capabilities available)

## Stowage Requirements

Please provide the following:

|  |  |
| --- | --- |
| **Stowage Requirements** | |
| Thermal constraints? (up/down/pre-ops/post-ops; if applicable, include temperature range tolerances. If non-controlled ambient temperature is required, state “STANDARD AMBIENT) |  |
|  |  |
|  |  |
|  |  |

# Environmental Testing

## Random Vibration Testing

Random Vibration Testing of the payload may be required. Contact NanoRacks for the approved vibration test procedures including test setup. Contact NanoRacks for requirements prior to making the decision to vibration test or not.

|  |  |
| --- | --- |
| **Random Vibration Testing** | |
| Vibration Test Report (forward to NanoRacks) |  |
| Spectrum and profile |  |

NanoRacks requires a visual inspection and functional test prior to and after the vibration test. Customers may conduct a more in-depth inspection if needed but the following is the minimum required by NanoRacks.

|  |  |
| --- | --- |
| **Random Vibration Post-test Inspection** | |
| Include a memo in this safety data template addressing: |  |
| Inspect the interior for signs of debris or particles, etc. |  |
| Check appendages or deployables remain in stowed configuration. |  |
| Inspect external fasteners and secondary locking for integrity |  |
| Pre- and Post-inspection photos for flight safety verification closeout. |  |
| Pre- and Post-vibration functional test results |  |

# Pre-delivery Mechanical Compatibility Check (Fit Check) and Functional Test

Customers are encouraged to check Payload mechanical and functional compatibility with the NanoRacks Platform-1A/-2A prior to final delivery to NanoRacks.

|  |  |
| --- | --- |
| **Pre-delivery Mechanical Compatibility Check** | |
| Include a memo in this safety data template addressing: |  |
| Test with fit gauge (pass/fail) |  |
| Test comments (e.g. if test fails, reasons and mitigation actions) |  |
| **Pre-delivery Functional Compatibility Check** | |
| Include a memo in this safety data template addressing: | |
| Functional test with NanoRacks Platform-1A/-2A software (pass/fail) |  |
| Test comments (e.g. if test fails, reasons and mitigation actions) |  |

# Additional Requirements

* + - 1. Provide requested crew interaction not covered by previous sections (e.g. crew photos, video, etc.).
      2. Provide any graphics or images to be placed inside or outside of the module (including size and format).   
         **NOTE:** For the exterior or the module, there are limits on the size, color and content. The module must meet requirements per JSC 27260F. This includes being on approved decal material, which is done to prevent decals from falling off or deteriorating due to humidity conditions. Providing a high resolution picture file of your decal and its size parameters by L-3M for late load or L-6M for nominal payload, enables NanoRacks to order the decal from the Decal Lab provisions offered by NASA.

# Appendix A – NASA Interpretation Letter TA-92-038

# Appendix B – Event Guidelines for Determining a Payload’s Timeline

Please provide a timeline for your payload that meets the criteria provided in Table A below:

**TABLE A: Timeline Data for Vehicle & Delivery Scenarios**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Event Guidelines**  **(“L” refers to Launch, “h” for hour, “d” for day, “w” for week, “m” for month)** | **SpaceX** | **Orbital** | **HTV/JAXA** | **Soyuz (if US has payload allocation)** | **Future COTS Vehicles** | |
| **Turn-Over to NanoRacks to allow for Close-Out processing & HFIT/Packing Reviews** | 1 week prior to NanoRacks turn-over (3 days prior if negotiated and manpower allows) | | | | | |
| **Nominal Cargo Turn-Over Required by NanoRacks to CMC** | L-9w | L-12w | L-6.5m | L-9.5w, unless negotiated and approved for L-8w alternative shipment | TBD | |
| **Late Load Cargo Turn-Over Required by NanoRacks to CMC/Cold Stow** | L-24d  OR  L-3d for temp controlled (ambient or cold). *This can be negotiated for as close in as L-28 hrs pending on Cold-Stow’s schedule and payload sample’s life limit priority. If it is a short-lived sample, you may need to arrange for hand-off at KSC to NanoRacks (ask about getting lab space)* | L-30d  OR  L-6d for temp controlled (ambient or cold). | L-10w | L-14d Requires special coordination/ approval (WARNING: this is rarely approved. Some L-35 day shipments have been approved in past) | TBD | |
| **Launch to Vehicle Docking with ISS** | L+1d to L+5d | L+2d to L+4d | L+5d | L+6 h or L+2d | TBD | |
| **Crew Access to Late Load Payload** | Docking + 12h to 24h | Docking + 12h to 24h | Docking +12h to 24h | Docking+ 5h to 24h | TBD | |
| **Allow Time for Thermal Stability… If Applicable** | If your payload is cold-stowed, how long does it need to come up to ambient before operations to prevent cooling another payload next to it in a NanoRacks facility? | | | | | |
| **So Assume Time from Turn-over to 1st Ops is** |  |  |  |  |  | |
| **Nominal Payload:** | 11w | 13.5w | 28w | 11w |  | |
| **Late Load Payload:** | 5w  -OR –  2w + thaw time if cold-stow | 6w  -OR –  2.5w + thaw time if cold-stow | 12w | 3.5w (difficult to get approved) |  | |
| WARNING!!! IF YOU HAVE BIOLOGICALS….IT WILL BE EXTREMELY DIFFICULT TO IMPOSSIBLE TO GET APPROVAL TO FLY ON NON-US VEHICLES. ALSO, THERE IS NO COLD-STOW SUPPORT PROVIDED FOR NON-US VEHICLES. | | | | | |

For example, if you have a payload that is to be:

* a “plug-n-play,” i.e. it’s a module that operates on-orbit by just plugging into a NanoRacks Frame,
* it contains a biological like worms or bacteria,
* it can be shipped +4C temperature to help ensure sample life,
* at best guess, the biologicals are viable for 8 to 9 weeks once you give it to NanoRacks (even if in cold-stow until operated)
* it requires data downlinks 3 times a week to provide sensor readings/pictures,
* it needs a minimum of 42 days (6 weeks) of un-interrupted (powered) operations – small interruptions (i.e. power recycle) having no affect,
* it can be thrown away once all 6 weeks of readings are completed,

Then your timeline could be written as:

1. L-6d: Turn-over to NanoRacks in Houston. 🡪 This let’s NanoRacks know a turn-over closer in than a week before their turn-over is needed and where you are delivering to; this also signals when the clock starts on sample’s life limit…
2. NanoRacks coordinates and completes all packing/HFIT reviews required with NASA
3. L-3d: NanoRacks turns over to Cold-Stow for +4C transport.
4. L-24h: Cold-Stow turns over to Vehicle personnel
5. Launch
6. NLT L+6d: Crew unpacks
7. Allow minimum of 2 hours to warm-up to ambient once unpacked from cold-bag
8. NLT L+7d (plus/minus 6 hrs): Plug into NanoRacks Platform-1 or -2
9. Power-up and operate for minimum of 42 days 🡪 This meets the 8 week minimum life-span estimate of the sample
10. Download data spaced out 3 times a week (e.g. Monday, Wednesday, Friday) for each week of powered operations.
11. Once all data transfers are completed and confirmed at end of 42 days, discard payload at earliest convenience.

# Appendix C – Switch Protection Requirements

**Switch Protection Requirements**

Payloads shall provide protection against accidental control actuation using one or more of the protective methods listed in A through G below. Infrequently used controls (i.e. those used for calibration) should be separated from frequently used controls. Leverlock switches or switch covers are strongly recommended for switches related to mission success. Switch guards may not be sufficient to prevent accidental actuation.

Note: Displays and controls used only for maintenance and adjustments, which could disrupt normal operations if activated, should be protected during normal operations, e.g., by being located separately or guarded/covered.

1. Locate and orient the controls so that the operator is not likely to strike or move them accidentally in the normal sequence of control movements.
2. Recess, shield, or otherwise surround the controls by physical barriers. The control shall be entirely contained within the envelope described by the recess or barrier.
3. Cover or guard the controls. Safety or lock wire shall not be used.
4. Cover guards when open shall not cover or obscure the protected control or adjacent controls.
5. Provide the controls with interlocks so that extra movement (e.g., lifting switch out of a locked detent position) or the prior operation of a related or locking control is required.
6. Provide the controls with resistance (i.e., viscous or coulomb friction, spring-loading, or inertia) so that definite or sustained effort is required for actuation.
7. Provide the controls with a lock to prevent the control from passing through a position without delay when strict sequential actuation is necessary (i.e., the control moved only to the next position, then delayed).