MICRO-G NEXT 2018 DESIGN CHALLENGES

Revised 10.05.2017

List of Micro-g NExT 2018 Design Challenges

NASA Microgravity NExT

Module Leak Repair System

Background

The International Space Station (ISS) is made up of pressurized modules that enable astronauts to live and work safely in space. One of the many risks involved in operating a spacecraft in Low Earth Orbit (LEO) is the potential of impacts to the spacecraft by Micrometeoroids and Orbital Debris (MMOD). While it is very remote, there is a small possibility for an MMOD impact to create a penetration of the pressurized module. This would cause the air to leak from the spacecraft creating a dangerous situation for those living on-board the spacecraft. In this scenario the astronauts would close the hatches of the leaking module, let the module depressurize and then perform a spacewalk to seal the hole.

Objective

Design and manufacture a device or devices that will enable astronauts, during a spacewalk, to repair a module that has been depressurized due to an MMOD impact.

Assumptions

- The module will be depressurized at the time of the EVA to repair the hole.
- The hole location is known.
- The rim of the hole will be flared inwards (Reference Figure 1).
- The angle of incidence of the hole will be between 0°(perpendicular to the surface) to 45° in any direction.
- The exact hole diameter will not be known until the astronauts begin the repair.
- Putting additional holes in the module is acceptable, as long as they don't create additional leaks.
- The astronaut is stabilized, has 2 free hands and can react small amounts of load.
- The device can have multiple parts that can attach and detach.

Requirements

1	The device/s shall be able to seal a hole between 0.5” - 1.0” in diameter.
2	The sealed hole must be able to withstand 14.7psi (The pressure inside module once repressurized).
3	The system can be manual, pneumatic or electrical. If the system is pneumatic or electrical it must meet additional NBL Requirements.
4	The total weight of all parts you provide should be less than 15 lbs.
5	The device/s shall be able to pack within a 12” x 16” x 18” volume.
6	Any removable components shall have a tether attachment point 1” in diameter.
7	All tools must be operable with EVA gloved hands (like heavy ski gloves).
8	Tools must not have holes or openings which would allow/cause entrapment of fingers.
9	Tools must be made from the NBL Approved Materials List or a waiver must be granted.
10	Lubricants must be selected from the NBL Approved Lubricant List or a waiver must be granted.
11	There shall be no sharp edges on the tool.
12	Pinch points should be minimized and labeled.
13	Tools shall be designed with drain holes or geometry to allow the free flow of air and water as required to support submersion and removal to and from the NBL pool.
14	Installation of the device protects the crew member from the sharp edges on the hole.

Test Setup

- The test piece will be 1/8” thick Aluminum (Reference Figure 2).
- A hole will be made in the test piece between the parameters given above:
  - 0.5” - 1.0” diameter
  - Angle of incidence between 0° and 45°
  - Inward flare
- This test piece will be rigidly mounted to a mockup in the NBL.
- After the repair is completed, compressed air will be turned on behind the hole at a low pressure to provide a means to visually show how well your device has repaired the hole.

References

Figure 1 – Picture of flared hole.

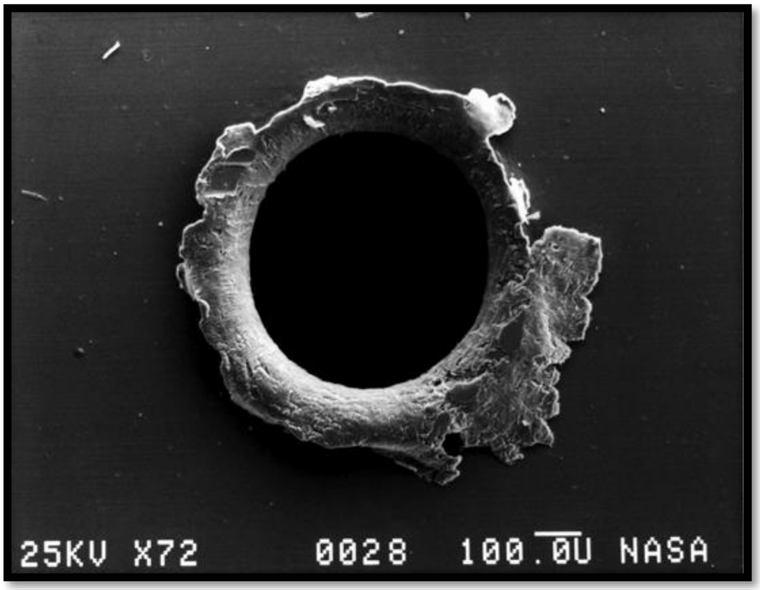
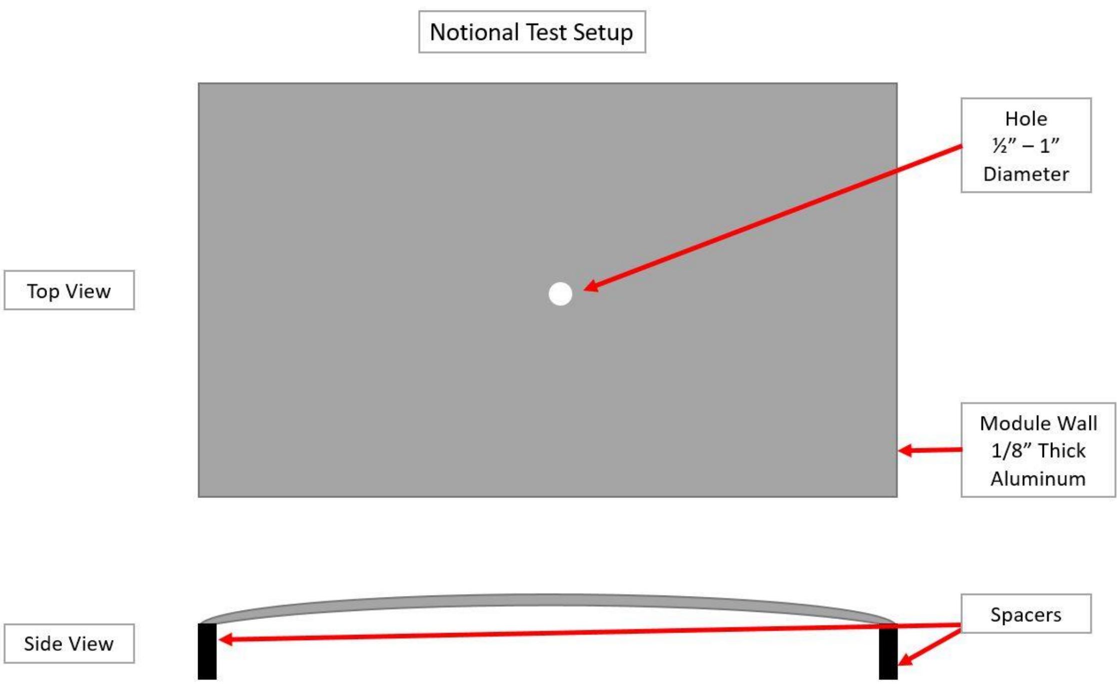


Figure 2 – Notional test setup for Module Leak Repair System.



Background

The International Space Station (ISS) has many handrails (Reference Figure 1) mounted on its exterior to enable astronauts to get around during Extravehicular Activities (EVA), or spacewalks. These handrails can develop sharp edges due to impacts by Micrometeoroids and Orbital Debris (MMOD). The sharp edges can be dangerous since they have the ability to cut parts of the spacesuit, in particular the gloves. This challenge is multifaceted. First, the astronauts need to be able to detect a sharp edge, which can be difficult when wearing a pressured spacesuit. Then, once located, the astronauts need to remove or cover the sharp edge without creating an additional hazard.

Objective

Design a method for both detecting sharp edges AND removing/or permanently covering sharp edges from an EVA handrail.

Assumptions

- The location of the sharp edge is not visible to the astronaut. It has to be detected by another method.
- The MMOD impact that creates the sharp edge will create a crater no bigger than 1/8” in diameter (Reference Figure 2).
- The sharp edge can appear on either of the three exposed handrail faces (Reference Figure 3). It can appear on any part of the profile (reference Side view in Figure 3).
- The astronaut is stabilized, has 2 free hands and can react small amounts of load.
- The device can have multiple parts that can attach and detach.

Requirements

1	The device/s shall be able to detect sharp edges that protrude between 0.01" – 0.06" from the surface of the handrail.
2	The device/s shall be able to remove or permanently cover the sharp edge to the greatest extent possible.
3	The structural integrity of the handrail must not be compromised.
4	The creation of Flying Object Debris (FOD) should be minimized.
5	The system can be manual, pneumatic or electrical. If the system is pneumatic or electrical it must meet additional NBL Requirements.
6	The total weight of all parts you provide should be less than 15 lbs.
7	The device/s shall be able to pack within a 12" x 16" x 18" volume.
8	Any removable components shall have a tether attachment point 1" in diameter.
9	All tools must be operable with EVA gloved hands (like heavy ski gloves).
10	Tools must not have holes or openings which would allow/cause entrapment of fingers.
11	Tools must be made from the NBL Approved Materials List or a waiver must be granted.
12	Lubricants must be selected from the NBL Approved Lubricant List or a waiver must be granted.
13	There shall be no sharp edges on the tool.
14	Pinch points should be minimized and labeled.
15	Tools shall be designed with drain holes or geometry to allow the free flow of air and water as required to support submersion and removal to and from the NBL pool.

Test Setup

- Each team will have at least 2 sharp edges to detect and remove.
- A simulated sharp edge will be placed somewhere on one of 3 exposed handrail faces (reference Figure 3).
- The test subject will use your tool to detect the sharp edge.
- Once located, the test subject will then attempt to remove the sharp edge.
- Confirmation the sharp edge has been removed can be done with your detection tool and/or by support divers.

References

Figure 1 – Picture and dimensions of ISS EVA Handrail.

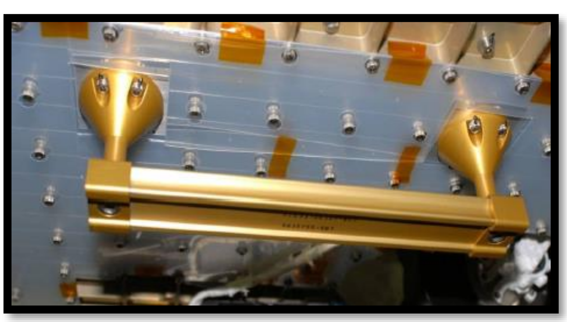
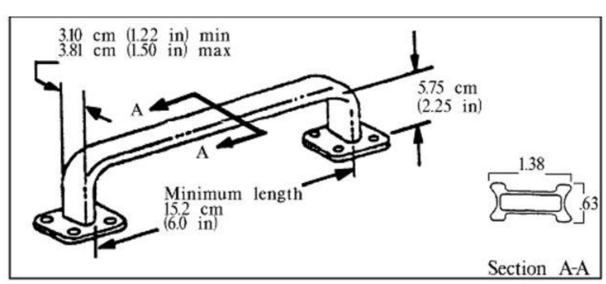
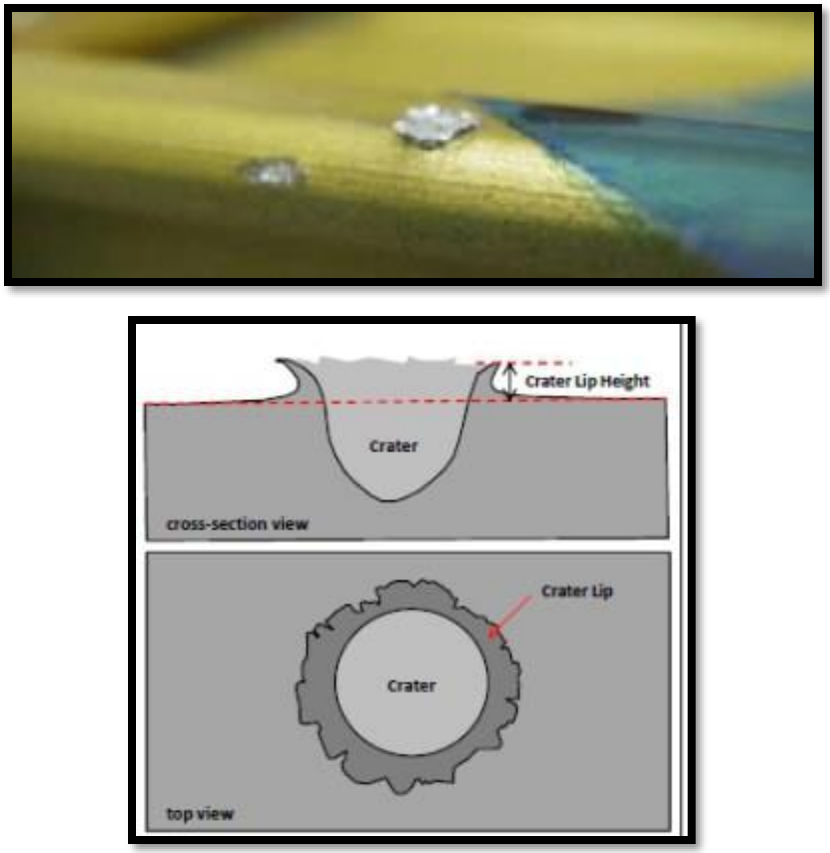


Figure 14.5.3.2-1 Standard EVA handhold Dimensional Requirements



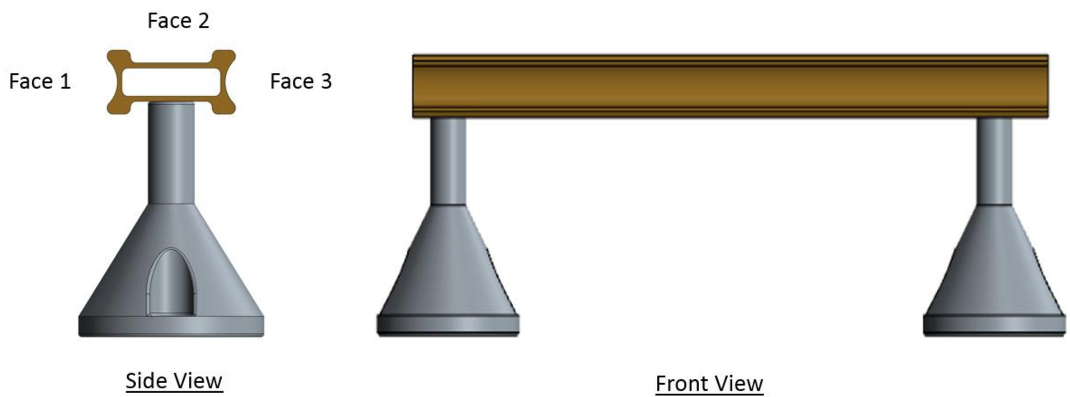
Note: Dimensions ± 0.15 cm (±0.060 in)

Figure 2 – Picture of MMOD impact on handrail with sharp edge.



Credit: Orbital Debris Quarterly News

Figure 3 – A sharp edge can develop on one of the 3 surfaces below.



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Zip Tie Cutters

Background

Zip ties are commonly used on payloads and hardware outside of the International Space Station (ISS). Often times they need to be removed during a spacewalk, or Extravehicular Activity (EVA), to complete a maintenance task or another EVA objective. These zip ties could be anywhere on the payload, including smaller spaces that are hard to reach. Since this occurs in microgravity, the zip tie needs to be captured once removed to keep it from floating away and potentially causing damage to the ISS or another piece of hardware.

Objective

Design and manufacture a device that can cut and retain a zip tie during an EVA in microgravity.

Assumptions

- Zip ties will be tightly installed.
- You will not always have access to the zip tie head.
- The zip ties could range from 0.1" – 0.375" in width and may have plastic or metal tangs, (reference Figure 1).
- The astronaut is stabilized, has 2 free hands and can react small amounts of load.
- The device can have multiple parts that can attach and detach.

Requirements

1	The device shall be able to cut and retain a tightly installed zip tie.
2	Damage to anything other than the zip tie should be minimized.
3	The device shall use only manual power.
4	The device shall be able to pack within a 4" x 4" x 12" volume.
5	The total weight of all parts you provide should be less than 8 lbs.
6	The device shall be capable of one-handed operation.
7	The device shall be ambidextrous.
8	The device and any removable components shall have a tether attachment point 1" in diameter.
9	All tools must be operable with EVA gloved hands (like heavy ski gloves).
10	Tools must not have holes or openings which would allow/cause entrapment of fingers.
11	Tools must be made from the NBL Approved Materials List or a waiver must be granted.
12	Lubricants must be selected from the NBL Approved Lubricant List or a waiver must be granted.

13	There shall be no sharp edges on the tool. Functional sharp edges are acceptable but should be exposed only during operations.
14	Pinch points should be minimized and labeled.
15	Tools shall be designed with drain holes or geometry to allow the free flow of air and water as required to support submersion and removal to and from the NBL pool.

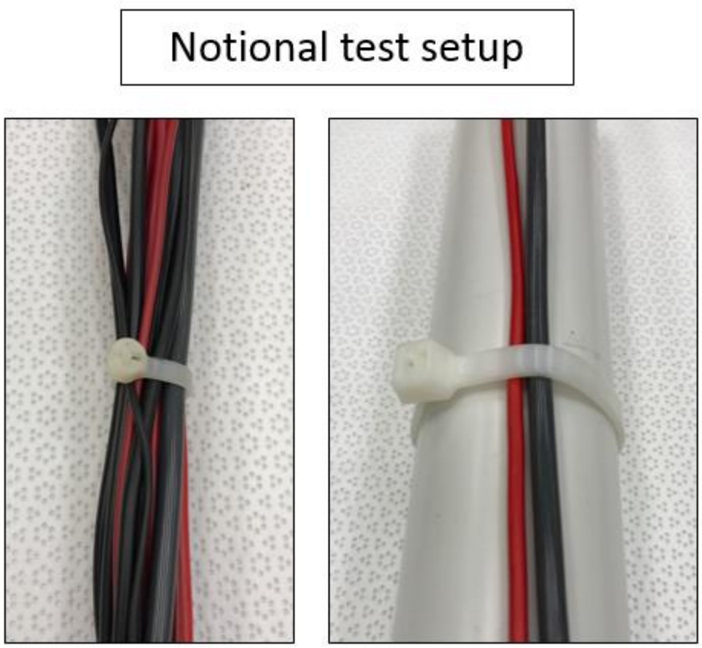
Test Setup

The test setup will have zip ties tightly installed around different geometries and equipment. Reference the notional test setup in Figure 2 showing different potential setups. Keep in mind the zip tie head will not always be accessible.

References

Figure 1 – Zip Tie with metal tang.

Figure 2 – Examples of potential test setups.



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Under Ice Sampling Device

Background

NASA is currently working on systems to explore underneath the ice-covered surface of so-called "Ocean Worlds" such as Europa and Enceladus. These systems are required to operate underwater and sample both the surrounding water and any ice-structures. These ice-structures may potentially serve as a structure upon which microbial life could thrive.

Objective

Design and manufacture a sampling device that interfaces with a submersible vehicle to obtain a subsurface ice sample in an underwater environment.

Assumptions

- The device will be provided 10lbf of buoyancy, but not be anchored in position.
- The device will NOT be attached to Buoyant Rover vehicle, but on a standalone platform.

Requirements

1	The device shall collect cylindrical samples 0.5" in diameter and 3" deep.
2	The device shall collect, seal, and store at least 1 sample.
3	The device shall obtain a subsurface sample from solid and slushy ice.
4	The device shall minimize cross contamination between samples
5	The device shall minimize contamination by air or water once obtained.
6	The device can be operated electrically by no more than 12V. Power to be supplied by the NBL only.
7	The device can have multiple parts that can attach and detach.
8	The device (all parts, in stowed configuration) shall fit within a 3" diameter x 6" long cylinder.
9	The device (all parts) shall operate underwater with provided electrical power.
10	The device (all parts) shall have a dry weight less than 5 lbs.
11	The device shall be commanded via general purpose input/output lines (3.3V or 5V compatible), or via a Universal Asynchronous Receiver / Transmitter (UART – 3.3V / 5V).
12	The device shall be compatible with a chlorine water environment and a salt-water environment.
13	The device shall operate within an environment from -5 deg C to 30 deg C.

Additional Desires

1	The device shall be able to collect, seal, and store at least 3 samples.
2	The device shall maintain the stratigraphy of the sample during collection, containment, and transportation. The sample shall not melt.
3	The device shall allow for removal of samples for verification that the stratigraphy is maintained.

Figure 1 – Rover dimensions.