



MICRO-G NEXT

Neutral Buoyancy Experiment Design Teams

Additional Requirements for Students Projects

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1. Tools

- a. All International Space Station tools must have a tether loop which will allow the test subject to use a tether with hooks (similar to a carabiner hook) to restrain the tool.
- b. All tools must be operable with extravehicular activity (EVA) gloved hands.
- c. Tools must not have holes or openings which would allow/cause entrapment of fingers.

Electrical Power Requirements

- a. Acceptable Power Sources
 - i. 12VDC 25A power source supplied by the NBL
 - ii. Up to 30VDC or less marine grade AGM sealed batteries for devices being submerged underwater
 - iii. Up to 30VDC ROV batteries for devices no submerged underwater
- b. The interface connection will consist of positive and negative female banana plug connections (see photo below).

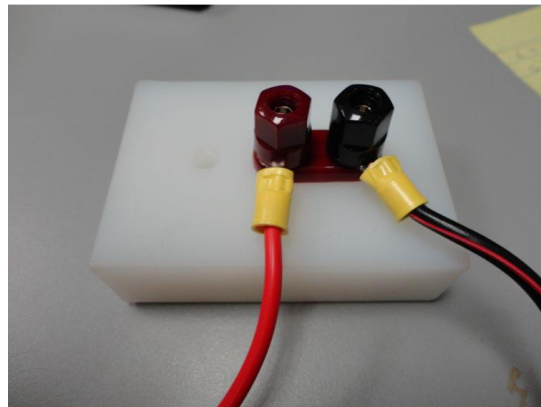


Figure 1: NBL Banana Plug Recetacle (electrical power)



Figure 2: Example Banana Plug Connectors

- c. Tool must incorporate a verifiable barrier to electric shock. A 25A fuse should be incorporated into the cable from the project to the power supply.
 - i. It is highly recommended that the fuse be located near the power supply end of the cable.
 - ii. Do not locate the fuse internal to your project. The proper fuse must be visually verified, or the project will not be allowed underwater.
- d. Use adequate strain relief to help mitigate detachment of the umbilical (where it attaches to the vehicle). Ensure the strain relief does not interfere with the operation of the vehicle (e.g. block movement of a rudder).

Pneumatic Power Requirements

- a. Student projects will be allowed to connect to the NBL's compressed air system:
 - i. Pressure – 125 psig
 - ii. NBL Shop Air Connector details:
 - Grainger: Coupler Plug, M(NPT), Item #1HLZ8, Mfr. Model #A73440-BG
 - Note: female P/N is 1HLZ9
 - Quick Coupler Body, (F)NPT, Steel Item #1HUK7, Mfr. Model #A73410-BG
 - JSC Engineering will supply the umbilicals

2. Other Requirements

Environmental Condition – NBL Pool Use:

- a. A totally submerged condition in water that contains a range of 0.5 to 3.5 parts per million of free chlorine.
- b. Ambient temperature range: +82°F (27.8°C) to +88°F (31.1°C).
- c. Some of the projects may be tested on the pool floor at a depth of 40 feet.

Acceptable Materials for use in the NBL

- a. Allowable materials: typical engineering metal alloys (e.g. stainless steel, aluminum, titanium), plastics, composites, or soft good materials are acceptable for short term testing in the pool.
- b. Allowable lubricants, coatings, foam, or adhesives are shown in [Appendix A](#).
- c. Other materials (e.g. gels) must be approved for use in the pool.

Sharp Edges and Protrusions

- a. Due to the potential for personal injury to diving support personnel and damage to the EVA suit, the mockup components shall not contain sharp edges or be capable of cutting or puncturing items coming into contact with them.
- b. Avoid, or protect the handler from, pinch points and/or sharp edges.
- c. The hardware shall be designed to specify manufacturing to remove burrs, break all sharp edges, and round all corners.

Water Entrapment

- a. Mockups and hardware 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.

Labels

- a. The hardware provided shall have labels as follows:
 - i. Mate/de-mate alignment marks, operation indicators, as required.
 - ii. Caution and warning tags for hazard areas (e.g. pinch points, sharp edges, etc.)
 - iii. Hardware identification.
 - iv. Additional safety labels may be requested following the Test Readiness Review.

Loads

- a. The hardware must withstand normal handling or kickloads and not present a safety hazard.

Appendix A: NBL Materials List

NBL Approved Foam Material List

Material Designation	Manufacturer
DOW Polystyrene Highload 60 Grade Blue Foam (64 lb/ft ³ buoyancy)	Ryder Insulation Corporation
Last-A-Foam (20 lb/ft ³ buoyancy)	General Plastics Manufacturing Corporation

NBL Approved Coatings Material List

Product	Suggested Vendors
Carboline 139 (Paint)	Carboline Company
Carbomastic 15M500 and 890	Carboline Company
Dupont 25P	Briggs Weaver
Ethone M-0-N (Marking Ink)	
Ethone M-5-N (Marking Ink)	
Ethone M-9-N (Marking Ink)	
Hi-Solids Catalyzed Epoxy	The Sherwin-Williams Company
NSP 120	NSP Specialty Products
Plasite 7122 (Paint)	Wisconsin Protective Coatings Corp.
UT Plast Super (non-epoxy)	UTP Welding Technology

NBL Approved Lubricants

Material Designation	Manufacturer
Braycote 601	Castrol Specialty Prod.
Braycote 602	Castrol Specialty Prod.
Braycote 803RP	Castrol Specialty Prod.
Christo-lube MCG-117	Lubrication Tech. Inc.
Halocarbon 25-10M	Halocarbon Corp.
Halocarbon 25-20M	Halocarbon Corp.
Halocarbon 25-5S	Halocarbon Corp.
Halocarbon 25-5SI	Halocarbon Corp.
Halocarbon 27S	Halocarbon Corp.
Halocarbon X90-10MS	Halocarbon Corp.
Krytox 280 AC	Dupont
Krytox 240 AC	Dupont
LOX-8	Fluoramics Inc.
Lubricant/Tef-Gel PTFE 9002-84-0	Utility Safety Systems Inc.
Mobil - 28	Mobile
SAF-T-EZE	SAF-T-EZE Div, STL Compound Corp
Tiolube 460 Dry Film Lubricant	Tiodize Co., Inc., Huntington Beach, CA

Tiodize Type II (Titanium Hard Coat)	Tiodize Co., Inc., Huntington Beach, CA
Tiodize Type IV (Tiodize Type I plus Tiolon X40 Teflon Coating)	Tiodize Co., Inc., Huntington Beach, CA

Appendix B: Previously Approved Materials

Acceptable Materials – Supplemental

- a. Metal adhesive – Supreme 10HT from Masterbond
 - i. Must be fully cured
- b. Nylon – Prohibited from the standpoint of reliability for NBL hardware in terms of continuous or long-term submersion but should be acceptable for this application. We could have scrubbed this material from the “prohibited” list for the competition, but the prohibited part was strictly intended for the continuous use NBL hardware used for EVA training.
- c. Nitinol (Nickel Titanium) – approved
- d. Loctite Epoxy Plastic Bonder – Can be used in the manufacture of their tool outside of the NBL, once its cured, there shouldn't be any issue. If they want to use/apply it in the facility, then then would need to go through the process for approval, make sure we have the correct safety PPE and precautions, etc.
- e. The following are allowed into the NBL as long as they are fully dried and cured:
 - i. Krylon Enamel Spray Paint (purchased at Lowes Home Improvement)
 - ii. Painters Fine Tip Red Paint Pen (purchased from Walmart) (Oil Based)
 - iii. JB Weld (purchased at Lowes Home Improvement)
 - iv. Kingspan Insulation R10 Unfaced Polystyrene Foam Board Insulation (Purchased from Lowes Home Improvement)
- f. FOAMULAR 150 Extruded Polystyrene Insulation manufactured by Owens Corning (Purchased from Home Depot)
 - i. Link: <http://www.homedepot.com/p/Owens-Corning-FOAMULAR-150-2-in-x-4-ft-x-8-ft-R-10-Scored-Squared-Edge-Insulation-Sheathing-45W/100320352>