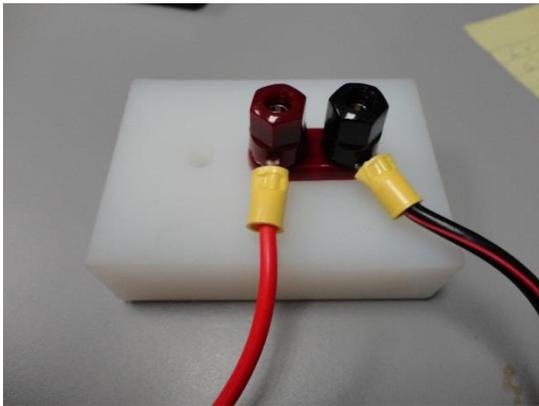


Additional NBL Engineering and Safety Requirements for Student Projects

1. Tools

- a. All tools must have a tether loop which will allow the astronaut to use a tether with hooks (similar to a carabiner hook) to restrain the tool
- b. All tools must be operable with EVA gloved hands (like heavy ski gloves)
- c. Tools must not have holes or openings which would allow/cause entrapment of fingers
- d. Electrical Power Requirements
 - i. Student projects will only be allowed to connect to the NBL's electrical power source: the interface we provide is a 12vdc 25 amp power supply. The interface connection will consist of positive and negative female banana plug connections (see photo). No other electrical power sources will be allowed.
 - ii. Tool must incorporate a verifiable barrier to electric shock

NBL's Banana plug receptacle (electrical power):



Example banana plug connectors:



e. Pneumatic Power Requirements

- i. Student projects will be allowed to connect to the NBL's compressed air (shop air) system:
 1. Pressure – 125 psig (a regulator will be provided to reduce pressure within operating limits of your tool)
 2. NBL Shop Air Connector details:

- a. Grainger: Coupler Plug, (M)NPT, Item# 1HLZ8, Mfr. Model# A73440-BG
 - i. Note: the female P/N is 1HLZ9
 - b. Quick Coupler Body, (F)NPT, Steel Item# 1HUK7, Mfr. Model# A73410-BG
3. JSC Engineering will supply the umbilicals

2. Other Requirements

- a. Environmental Condition - NBL Pool Use:
 - i. A totally submerged condition in water that contains a range of 0.5 to 3.5 parts per million of free chlorine
 - ii. Ambient temperature range: +82° F (27.8° C) to +88° F (31.1° C)
 - iii. Some of the projects may be tested on the pool floor at a depth of 40 feet
- b. Acceptable materials for use in the NBL
 - i. 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.
 - ii. Allowable lubricants, coatings, foam, or adhesives are shown in Attachment 1
 - iii. Other materials (e.g. gels) must be approved for use in the pool
- c. Sharp Edges and Protrusions
 - i. Because of 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
 - ii. Avoid (or protect the handler from) pinch points and/or sharp edges
 - iii. The hardware shall be designed to specify manufacturing to remove burrs, break all sharp edges and round all corners
- d. Water Entrapment - 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
- e. Labels - 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 (i.e., pinch points, sharp edges, etc.).
 - iii. Hardware identification
 - iv. Additional safety labels may be requested by Test Readiness Review (TRR).
- f. Loads – the hardware must withstand normal handling or kickloads and not present a safety hazard

ATTACHMENT 1 – NBL MATERIAL LISTS

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 Mfg Corporation

Table 17: NBL Approved Foam 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

Table 19: NBL Approved Coatings Material List

Product	Suggested Vendors
3M Adhesive Sealant Fast Cure 5200	N/A
3M Spray Adhesive	N/A
Dexter 0151 Hysol Epoxi-Patch Structural Adhesive	N/A
GE Translucent RTV 108 Silicone Rubber Adhesive Sealant	N/A
Labels: Thermatab Markers, THT-107-423	BRADY Worldwide 1-800-537-8791 www.bradyid.com
Loctite 608 Hysol Epoxi-Patch Adhesive	N/A

Product	Suggested Vendors
Plexis MA 422 FRP adhesive	N/A
PVC Heavy Duty Cement.	N/A

Table 20: NBL Approved Miscellaneous Items

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
Kyrtox 240 AC	Dupont
LOX-8	Fluoramics Inc.
Lubricant / Tef-Gel PTFE 9002-84-0	Ultra 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 II plus Tiolon X40 Teflon coating)	Tiodize Co., Inc., Huntington Beach, CA

Table 21: NBL Approved Lubricants