Additional Requirements for Student Projects

1. Tools

a. All ISS 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. The 12VDC 25A power source supplied by the NBL shall be used as the only power source. Any other power source, such as cells, batteries, capacitors, etc. shall be strictly prohibited.

ii. The interface connection will consist of positive and negative female banana plug connections (see photo).

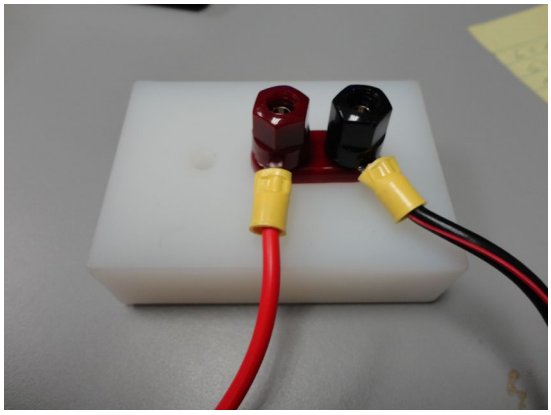
iii. Tool must incorporate a verifiable barrier to electric shock. A 25A fuse should be incorporated into the cable from the project to the power supply.

1. It is highly recommended that the fuse be located near the power supply end of the cable.

2. Do not locate the fuse internal to your project. The proper fuse must be visually verified, or the project will not be allowed underwater.

iv. 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)

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
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/ft3 buoyancy)	Ryder Insulation Corporation
Last-A- Foam (20 lb/ft3 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
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

Other materials that have been approved in previous Micro-G sessions:

Acceptable Materials – Supplemental

1. metal adhesive: Supreme 10HT from Masterbond – must be fully cured
2. 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. .

3. Tacky Tape: While making our tool we stumbled upon a sort of putty tape that can help us put our tool together. It is called tacky tape, it is an asbestos-free butyl tape--see links provided: (http://tacky-tape.com/products/vacuum-bags/sm5190/) or (http://www.schneemorehead.com/pdf-sm/SM5227TDS.pdf). The NBL is fine with this. The MSDS looks good.
4. Nitinol (Nickel Titanium) – OK
5. Thinner for the Biodur wall patch epoxy we use is NOT approved yet (we don't use the thinner)
    a. What is already approved for use in the pool: Bio-DUR http://www.biodurproducts.com/en/products/polymers_chemicals.html
6. Loctite Epoxy Plastic bonder: http://www.loctiteproducts.com/p/epxy_plstc_s/technical-data/Loctite-Epoxy-Plastic-Bonder.htm 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 they would need to go thru the process for approval, make sure we have the correct safety PPE and precautions, etc.
7. SAF-T-EZE, but it does not specify which product we can use from that manufacturer.

    http://www.shopping.saftlok.com/cart-anti-seize.htm
    Any grade would be acceptable as the type is specific for the application (food grade, etc.) or the material specified. Each has its own blend of materials for each application however, I don't see anything that would pose an additional hazard.

8. I have no issues with bringing these materials into the facility as long as they are cured and dried.
    a. Krylon Enamel Spray Paint (purchased at Lowes Home Improvement)
    b. Painters Fine Tip Red Paint Pen (purchased from Walmart) (Oil Based)
    c. JB Weld (purchased at Lowes Home Improvement)
    d. Kingspan Insulation R10 Unfaced Polystyrene Foam Board Insulation (Purchased from Lowes Home Improvement)
9. OK to use this foam in the neutral buoyancy lab: FOMULAR 150 Extruded Polystyrene Insulation manufactured by Owens Corning. The product link is:

    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

10. Carbocoat 8215 OK if fully cured and dried Shane Pennington: This product is manufactured by Carboline Coatings a global supplier of coatings, linings, and fireproofing. The NBL has an approved list of coatings contained in CX12-SLP0014 Neutral Buoyancy Laboratory Mockup and Training Hardware Requirements. Two of the approved coatings (890 & 139) on this list are made by Carboline and are very similar to the requested product in use and hazards, including the carcinogenicity category, so it is possible. In order to apply this product here at the NBL we would need to establish how they would apply the product so that we can ensure adequate ventilation and they would need to be wearing an adequate respirator in order to avoid inhalation of spray-mist and sanding dust, all spraying and sanding must be done wearing adequate respirator, gloves and safety glasses. We would also address flammability when determining the work area. As far as environmental concerns we would need to ensure the liquid product doesn't make its way into any drains, storm or sewer. We would dispose of waste using existing JSC forms. If they are bringing it into the facility already applied to a part and won't be sanding or grinding on it then there are no hazards to handling it in its cured form and I wouldn't be opposed to them using it. Thanks, Shane p.s. All of the concerns mentioned above are applicable wherever they are using it. Those hazards need to be addressed at their school as well.