



NASA SBIR 2016 Phase I Solicitation

H4.01 Dust Tolerant, High Pressure Oxygen Quick Disconnect for Advanced Spacesuit and Airlock Applications

Lead Center: JSC

In order to support the Extra Vehicular Activity (EVA) Systems development for more robust operation in LEO as well as enabling operation in the lunar and Martian environments, technology development is required for high pressure oxygen (3750 psia) quick disconnects. The current state of the art space suit ISS EMU Umbilical (IEU) and Service and Cooling Umbilical (SCU) connectors operate at a lower pressure and nearly zero contaminant environment. These next generation of quick disconnects (QDs) will enable the EVA systems to transfer high pressure oxygen between the vehicle and on-board tankage under adverse conditions including vacuum and dust (lunar regolith and Martian soil). The QDs expected operating thermal environment range is -50°F to 150°F . The QDs will limit dust intrusion into the internal flow such that when mated/demated 300 times with the environment per MIL-STD-810G, Method 510.5, Procedure I (Blowing Dust) using lunar soil simulant JSC Lunar-1A or JSC Mars-1A, the internal fluid flow downstream of internal filtration is maintained at Level 100A per JPR 5322.1. After those same mate/demate cycles, the fluid flow range will be 0-12 pph of gaseous oxygen at 2800-3750 psia with an allowable pressure drop of 49 psi. The allowable leakage at 3000 psia is 1 scc/hr oxygen. The QD shall exhibit low mating forces such that it can be mated by crew with gloved hands (wearing a spacesuit with a 4.3 psia or 8.3 psia operating pressure) using simple motions such as push/pull or push-twist/twist-pull. Single handed, gloved operation is preferred. A simple means of indicating positive QD engagement is preferred. The use of accessory tools to aid in QD mate/demate should be avoided if possible. The connector shall be capable of reacting a 125 lbf pull force at the strain relief. There are no specific requirements levied upon the exterior size and complexity of the QDs other to state that they are high criticality items that must be safe, practical, reliable; and a device that an exhausted crew member could operate easily and intuitively. Significant work has been done by NASA to identify a mechanical design for the basic size and operation of the device. Reference material has been attached describing existing and new designs, which NASA expects to heavily influence the general form, fit, and function of the future high pressure quick disconnect.

Research done in Phase I of these efforts should focus on technical feasibility with an emphasis on hardware development that can be further expanded in a future Phase II award cycle. Phase II products must include a demonstration unit suitable for testing by NASA. Prototyping should be tailored to applications to ongoing HEO Mission Directorate missions and possible collaborative use in both the governmental and commercial manned spaceflight disciplines. Minimum deliverables at the end of Phase I are analysis and/or test reports, with priority given to functional hardware prototypes for further evaluation. Technical maturation plans should be submitted with Phase I submittals, as well as any expected commercial applications both internal and external to the manned spaceflight enterprise.

ISS EMU UMBILICAL (IEU)

The ISS EMU Umbilical (Item 498) is an interface between the ISS Umbilical Interface Assembly (UIA) and the Extravehicular Mobility Unit (EMU). It provides electrical power and communication, water fill/drain, and water cooling capability from the International Space Station (ISS) for the EMU. The IEU consists of the following items:

three water lines of which two are used for water cooling of the LCVG and one for feedwater charging and condensate draining of the PLSS, one oxygen line, one electrical harness assembly for power and communication, a tether restraint and the TMG. The Common Multiple Connector, Item 410, provides a single interface point for connecting and disconnecting the IEU from the DCM. An Umbilical Connector Manifold (UCM), which is government furnished equipment (GFE), provides a single IEU attachment point to the ISS UIA. The IEU provides recharge capability for the PLSS oxygen tank, water reservoir, and battery. In the event a decontamination EVA is needed, the umbilical is designed to withstand environments external to the Airlock.Â

The EMU umbilical terminates at each end with a ganged multiple connector that requires only a single operation to connect or disconnect the umbilical.Â

The outer layer of the IEU is a multi-layer Thermal Micrometeoroid Garment (TMG) to provide thermal insulation and protection from micrometeoroid impacts. The IEU includes a protective pouch that will provides thermal and impact protection for the IEU common multiple connector while disconnected from the EMU.Â

The Umbilical contains a strain relief strap which, during IV operations, attaches via a GFE tether hook to one of the Lower Torso Assembly (LTA) D-rings at the EMU end and to a separate tether ring on the Crew Lock (CL) wall. For EV operations, the hook is disengaged from the UIA panel ring and is secured to a D-ring near the UIA panel. In the event that an EVA decontamination bake out of the EMU is required, this tethering scenario will serve to ensure that UIA design loads are not exceeded.Â

While not in service (i.e., when completely disconnected from the UIA and EMU), the umbilical is stowed in the equipment lock. While attached to the UIA, the umbilical is restrained against the CL wall by GFE provided restraint straps.

The useful life (combination of the operational life and shelf life) of the Umbilical is 15 years from the date of PDA. The dry weight of the Umbilical does not exceed 30 lbm. This weight includes all GFE provided hardware (2 tether hooks and the UCM). Â

Service and Cooling Umbilical (SCU)Â

The Service and Cooling Umbilical (Item 400) is an 11-ft umbilical consisting of three water hoses, a high-pressure oxygen hose, electrical harness, bacteria filter assembly, and a strain relief tether. The SCU supplies the PLSS with electrical power, communications, oxygen, waste water drainage and water cooling from the Orbiter during pre- and post-EVA operations. It also supplies the EMU with recharge of the oxygen tanks, water tanks, and battery.Â

The end of the SCU that connects into the airlock panel, otherwise known as the vehicle end of the SCU, consists of the four fluid ECLSS connections in addition to one electrical connector that attaches the SCU to the Orbiter airlock service panel AW82. The connections remain intact between flights and do not require crewmember operation. The vehicle waste water drain and potable water fill lines are connected to the bacteria filter housing located on the airlock wall. On both the drain side and the potable water fill side, a bacteria filter of iodine-impregnated epoxy resin spheres is incorporated, along with a particulate filter made of sintered stainless steel. These filters are used to prevent contamination from passing between the Orbiter ECLSS and the EMU. During normal IVA operations, the Orbiter Waste System is off and there is no ability to dump excess condensate. Approximately one pound of water is drained from the EMU water tanks after filling to allow room for condensate while IVA.Â

The common connector on the EMU end of the SCU combines the four fluid connections and one electrical circuit connector into a single unit operated by the crewmember. Disengagement of the connector is accomplished by pulling out on the SCU connector cam T-handle to retract a locking pin and then rotating the cam handle from the â€œlockedâ€ position approximately 180Â° to a detent, which is the â€œopenâ€ position. This rotation of the SCU connector cam disengages two pins on the mating is accomplished by pulling out on the SCU connector cam T-handle to retract a locking pin and then rotating the cam handle from the â€œlockedâ€ position approximately 180Â° to a detent, which is the â€œopenâ€ position. This rotation of the SCU connector cam disengages two pins on the mating connector. Engagement of the connector is accomplished by rotating the SCU connector cam T-handle to the â€œopenâ€ position, engaging the two pins on the mating connector with the cam, and then rotating the cam handle from the â€œopenâ€ position approximately 180Â° to the â€œlockedâ€ position, where a cam locking pin is engaged.Â

The SCU is stowed on the airlock wall when it is not being used. The common connector (SCU side) is attached to a mating stowage connector on the EMU mount (AAP). The SCU is unstowed and connected to the DCM during EMU donning to provide vehicle consumables for the suited EVA preparation activities in the airlock until life support from the EMU is initiated. Nominally, the SCU is disconnected at an airlock pressure of zero psia during airlock depressurization prior to an EVA and reconnected at an airlock pressure of zero psia during airlock re-pressurization after an EVA. The life support from the SCU is maintained during the suited post-EVA activities until the start of EMU doffing. The SCU is also connected to the EMU to supply Orbiter consumables for recharge of the EMU oxygen, the water tanks, and the battery.

ITAR restricted background on exploration space suit umbilical design requirements and expectations may be found at the following website (in cases where the solicitation requirements disagree with the references, the solicitation takes precedence.):

- Contract NNJ09T40C, Constellation Space Suit Systems ISS Umbilical Assembly, CSSS-T-002 Rev. DRAFT X-2, 7 July 2015. (http://sbir.gsfc.nasa.gov/SBIR/solicitations/2016/CSSS-T-002_LSS_CEL_ISS_Umbilical_Assembly_Specification.pdf)
- Contract NNJ09T40C, Constellation Space Suit Systems ISS Umbilical Assembly, Exploration EVA Space Suit Design Status Review, 26 August 2015. (http://sbir.gsfc.nasa.gov/SBIR/solicitations/2016/Umbilical_and_Connector_Section_CSSS_DSR_Day_2_P M.pptx)

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