NASA SBIR 2020 Phase I Solicitation

H4.05 Liquid Cooling and Ventilation Garment Connector Upgrade and Glove Humidity Reduction

Lead Center: JSC

Technology Area: TA6 Human Health, Life Support and Habitation Systems

Scope Title

Liquid Cooling and Ventilation Garment (LCVG) water loop connector upgrade and glove humidity reduction

Scope Description

LCVG water connector upgrade:The connector of the liquid cooling and ventilation garment (LCVG) for the space suit has been a source of failures in the current extra-vehicular mobility unit (EMU). Increased reliability and durability are needed for future space suits that will be used during long-duration missions, which include periods (up to 6 months) of quiescence. Two primary design problems can be addressed:

1) Cold flow of the ethyl-vinyl acetate tubing at the connection to the LCVG connector, which causes leaks to form

2) Sticking of the poppet seal, which allows the LCVG connector to leak. The poppet seal sticks after the seal lubricant is washed away.

A requirement that increases the challenge in designing a non-sticking poppet seal is, because the poppet seal is in the water loop of the space suit, the seal material used must maintain the high water quality requirements for the space suit water loop. Water leakage from the LCVG thermal loop connectors shall be less than 0.5 cc/hr when running at nominal operating pressure of 15 psid.

The connector should not generally leach material into the water flowing through it. Therefore, the connector needs to maintain water quality to the following levels in order to avoid affecting the performance of other equipment within the space suit water loop. In addition, galvanic corrosion in the water loop is of concern. Therefore the connector wetted surfaces, and in general the body should be constructed out of Titanium 6Al-4V wherever possible and stainless steel when necessary. Aluminum alloys should be avoided. Other wetted materials, such as seals or gaskets would preferably be constructed out of currently-used materials such as silicones.

The connector would also need to be compatible with the water solution of Iodine at concentrations of 0.5 – 5 ppm.

Additionally, the connector would need to be compatible with inlet water containing contaminants such as those listed below:

Contaminant	Amount (mg/L)
Barium	0.1

Calcium	1
Chlorine	5
Chromium	0.05
Copper	0.5
Iron	0.2
Lead	0.05
Magnesium	1
Manganese	0.05
Nickel	0.05
Nitrate	1
Potassium	5
Sulfate	5
Zinc	0.5
Organics	
Total Acids	0.5
Total Alcohols	0.5
Total Organic Carbon	0.3

Glove humidity reduction: Onycholysis due to humidity and water in space suit gloves during Neutral Buoyancy Laboratory (NBL) training and during extra-vehicular activity is a common observation. Ventilation in gloves is poor allowing moisture to accumulate, which contributes to onycholysis and results in nail bed damage, skin damage, and fungal infections. NASA seeks solutions to reducing moisture in space suit gloves. LCVG ventilation improvements that could ventilate the glove are difficult due to ducting required that would cross the elbow. This ducting is undesirable since it impedes mobility of the elbow joint. Alternative solutions are desired that will prevent onycholysis during suited operations.

The LCVG ventilation ducting consists of a ducting network with one duct running down each arm and each leg. See “Liquid Cooling and Ventilation Garment” description and images at “https://www.nasa.gov/audience/foreducators/spacesuits/home/clickable_suit_nf.html. The ventilation ducts end just above the elbows for the arms and at the feet for the legs. The ventilation gas enters the spacesuit at helmet and flows over the body because the ends of the ducts at the elbows and feet are open. The fan in the portable life support subsystem (PLSS) pulls the ventilation from these open ends and sends the gas to be processed before recycling it back to the helmet. Since the ventilation duct in the arms end at the elbows, the wrist and hand areas are not well ventilated.

References

“Liquid Cooling and Ventilation Garment” description and images located at the following link: https://www.nasa.gov/audience/foreducators/spacesuits/home/clickable_suit_nf.html.

A high-level schematic of the LCVG connector https://www.nasa.gov/suitup/reference/catalog

Expected TRL or TRL range at completion of the project: 2 to 5

Desired Deliverables of Phase II

Hardware, Research

Desired Deliverables Description

The phase 1 needs to deliver a detailed design solution with information that provides confidence that hardware fabricated in the Phase II will resolve the current design challenges.

State of the Art and Critical Gaps

The 30+ history of the EMU has demonstrated these two design weaknesses as a potential for space suit failures for the exploration space suit. Without new design solutions, the exploration space suit will be limited by these weaknesses. In preparation for the exploration space suit, solving these problems are critical.

Relevance / Science Traceability

This subtopic is relevant across the Moon to Mars portfolio. Any mission in which an extra-vehicular activity suit is utilized will benefit from the increased reliability of a suit in which the current connector flaws are rectified.