Active Project (2015 - 2015)

High Performance Mars Liquid Cooling and Ventilation Garment Project

Center Independent Research & Developments: JSC IRAD Program | Mission Support Directorate (MSD)

ABSTRACT

EVA space suit mobility in micro-gravity is enough of a challenge and in the gravity of Mars, improvements in mobility will enable the suited crew member to efficiently complete EVA objectives. The idea proposed is to improve thermal efficiencies of the liquid cooling and ventilation garment (LCVG) in the torso area in order to free up the arms and legs by removing the liquid tubes currently used in the ISS EVA suit in the limbs. By using shaped water tubes that greatly increase the contact area with the skin in the torso region of the body, the heat transfer efficiency can be increased to provide the entire liquid cooling requirement and increase mobility by freeing up the arms and legs. Additional potential benefits of this approach include reduced LCVG mass, enhanced evaporation cooling, increased comfort during Mars EVA tasks, and easing of the overly dry condition in the helmet associated with the Advanced Extravehicular Mobility Unit (EMU) ventilation loop currently under development.

ANTICIPATED BENEFITS

To NASA funded missions:

Reduced EVA space suit mass and increased mobility and comfort during EVA are the key benefits of this technology. If adopted, this technology would benefit current EVA's being performed at the International Space Station.

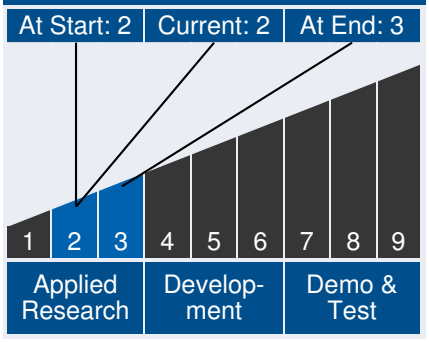
To NASA unfunded & planned missions:

Reduced EVA space suit mass, increased mobility and comfort during EVA are the key benefits of this technology which will be of even greater importance with Mars EVA's considering the added work loads and carry weight associated with the gravity of Mars.

High Performance Mars Liquid Cooling and Ventilation Garment

Table of Contents

Technology Maturity



High Performance Mars Liquid Cooling and Ventilation Garment Project

Center Independent Research & Developments: JSC IRAD Program | Mission Support Directorate (MSD)

To other government agencies:

Military personnel working in hot environments may also benefit from the increased cooling efficiencies offered by this technology.

To the commercial space industry:

Reduced intravehicular activity (IVA) space suit mass and increased mobility and comfort are the key benefits of this technology. If adopted, this technology would benefit space suits that support commercial high altitude and space flights.

To the nation:

With low mass and efficient cooling capabilities provided by this technology benefiting commercial, military, and NASA applications described above, the national benefits include the potential for reduced occurrences of the heat-related human error and injuries including heat stress and heat stroke. Medical conditions that require cooling of the body may also benefit from this technology.

DETAILED DESCRIPTION

EVA capabilities need to be robust to enable and achieve certain Evolvable Mars Campaign (EMC) goals including development of technologies that can evolve with the EMC missions and lead to an eventual landing on Mars. Also, Human Space Flight Architecture Technology (HAT) performance targets include reductions in mass of the Mars surface space suit to reduce overall mission mass and to help offset the increased crew member work loads associated with EVA's performed in the Mars gravitational environment.

The high efficiency LCVG approach has the potential to significantly improve suit mobility and comfort as well as to decrease the mass associated with the LCVG. Also, with an

Management Team

Program Director:
- Douglas Terrier

Program Executive:
- Douglas Terrier

Program Manager:
- Ronald Clayton

Project Manager:
- David Whitlock

Principal Investigator:
- Bruce Conger

Technology Areas

Primary Technology Area:
Human Health, Life Support & Habitation Systems (TA 6)

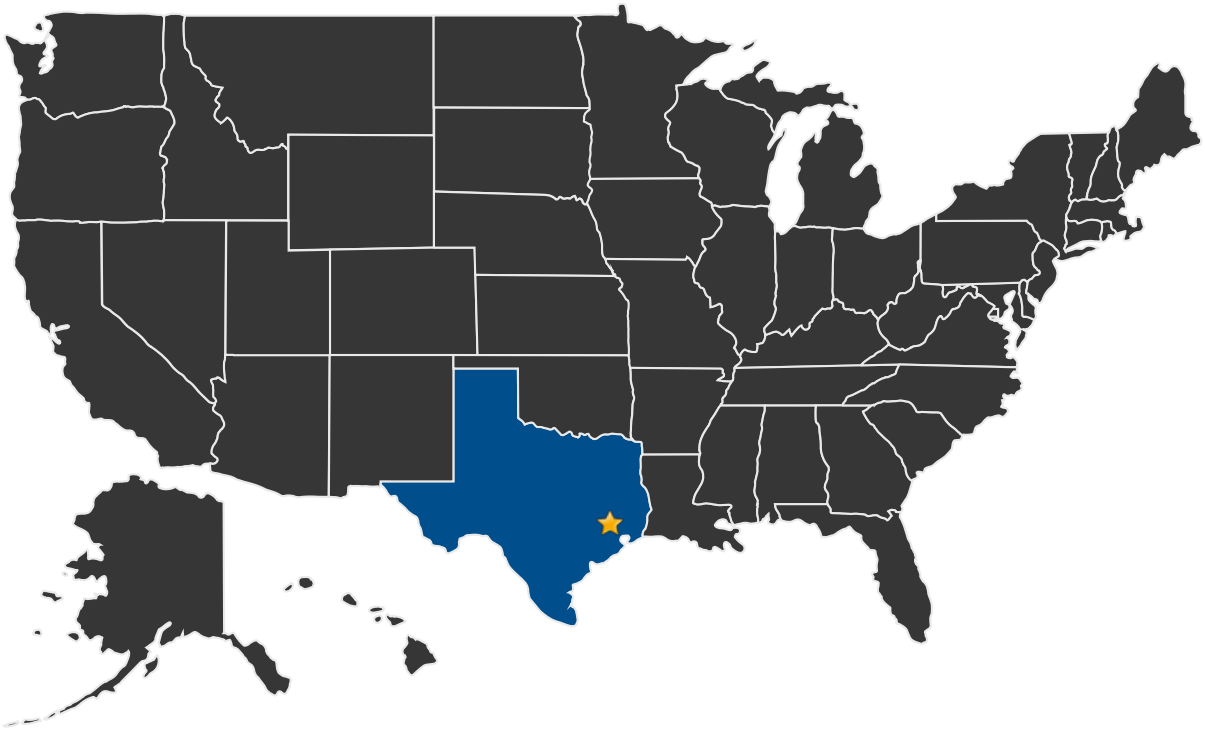
anticipated increase in evaporative cooling, over drying of the helmet inlet gas condition experienced in the current Advanced EMU ventilation loop (under development) may be mitigated. If LCVG efficiencies are significantly improved, the water temperature within the LCVG can be raised, and this could also lead to a reduction in the size of the suit cooling unit.

To prove whether this high efficiency approach will provide the anticipated increase in LCVG heat transfer efficiencies, sample LCVG sections are being built up and tested against sections representing the current LCVG water tube configuration. One challenge associated with the new water tube approach will be how to build up the header that feeds the water tubes in a manner that will not leak. Investigations will be made into this manufacturing approach and once the approach is shown to be successful, the water tube sections will be tested and heat transfer performance will be compared to sections built up to match the current LCVG technology.

High Performance Mars Liquid Cooling and Ventilation Garment Project

Center Independent Research & Developments: JSC IRAD Program | Mission Support Directorate (MSD)

U.S. LOCATIONS WORKING ON THIS PROJECT



U.S. States With Work

Lead Center:
Johnson Space Center

DETAILS FOR TECHNOLOGY 1

Technology Title

High Performance Mars Liquid Cooling and Ventilation Garment

Technology Description

This technology is categorized as a hardware component or part for wearable applications

A liquid cooling and ventilation garment (LCVG) with improved thermal efficiencies in the torso area can potentially free up the arms and legs by removing the liquid tubes currently used in the ISS

EVA suit in the limbs.

Capabilities Provided

Providing the full liquid cooling capability in the torso region of the body Improves the mobility and comfort in the arms and legs during EVA. Reduced mass of the LCVG will also increase EVA performance efficiencies.

Potential Applications

This technology may be a benefit to all NASA and commercial EVA and intravehicular activities (IVA) space suit applications as well as non-NASA applications such as for cooling firefighters, race car drivers, military personnel, and anyone else working in hot environments. Some medical conditions that require cooling of the body may also benefit from this technology.

Performance Metrics

Metric	Unit	Quantity
Overall heat transfer coefficient	W/m^2/K	80