


Johnson Space Center Engineering Directorate

L-8: Non-Venting Thermal Control Systems for Space Vehicles

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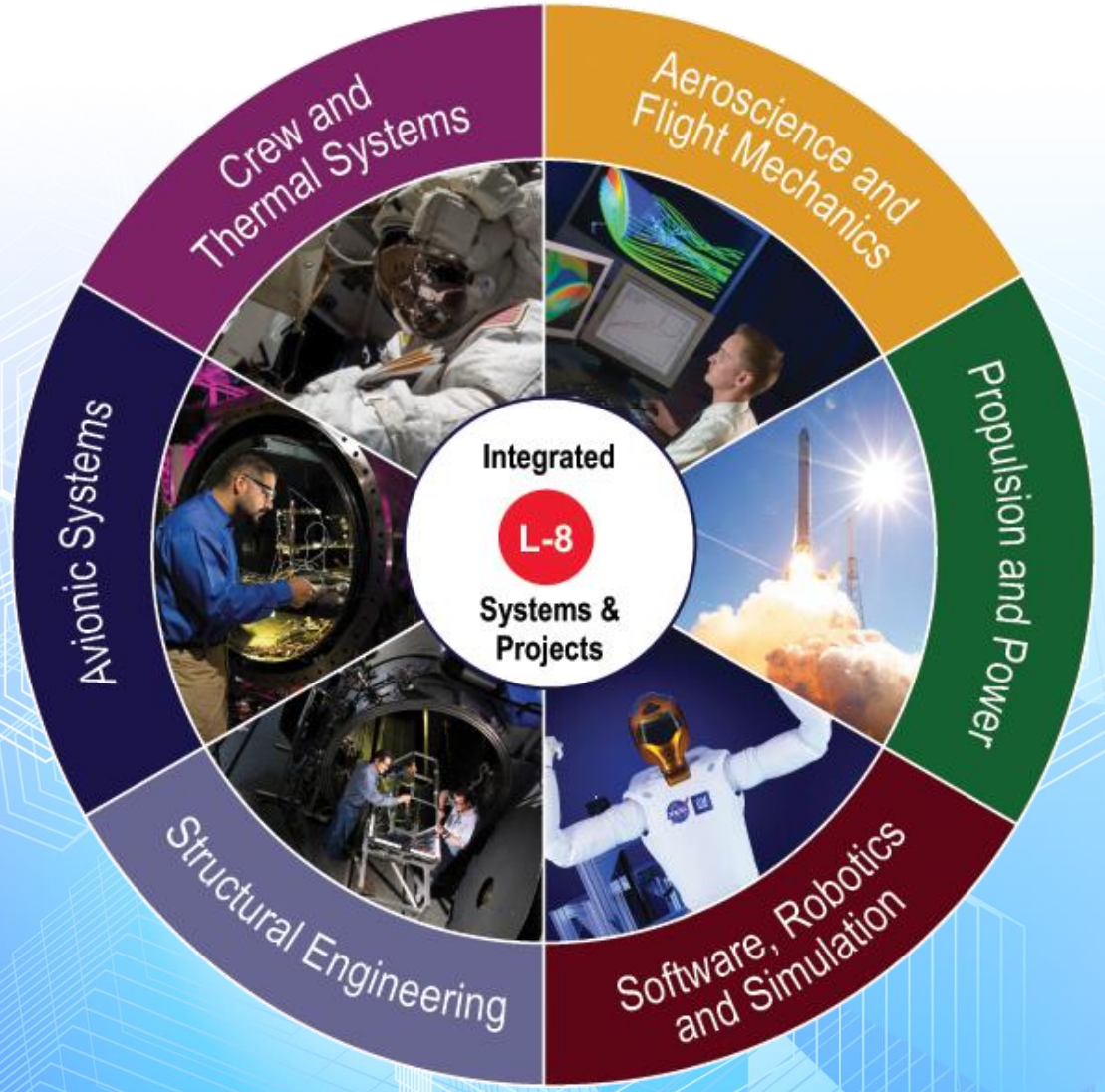
JSC Engineering: HSF Exploration Systems Development



- We are sharpening our focus on Human Space Flight (HSF) Exploration Beyond Low Earth Orbit
- We want to ensure that HSF technologies are ready to take Humans to Mars in the 2030s.
  - Various Roadmaps define the needed technologies
  - We are attempting to define our activities and dependencies
- Our Goal: Get within 8 years of launching humans to Mars (L-8) by 2025
  - Develop and Mature the technologies and systems needed
  - Develop and Mature the personnel needed
- We need collaborators to make it happen, and we think they can benefit by working with us.

Boilerplate

EA Domain Implementation Plan Overview

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- Life Support
- Active Thermal Control
- EVA
- Habitation Systems

- Human System Interfaces
- Wireless & Communication Systems
- Command & Data Handling
- Radiation & EEE Parts

- Lightweight Habitable Spacecraft
- Entry, Descent, & Landing
- Autonomous Rendezvous & Docking
- Vehicle Environments

- Entry, Descent, & Landing
- Autonomous Rendezvous & Docking
- Deep Space GN&C

- Reliable Pyrotechnics
- Integrated Propulsion, Power, & ISRU
- Energy Storage & Distribution
- Breakthrough Power & Propulsion

- Crew Exercise
- Simulation
- Autonomy
- Software
- Robotics

AA-2 | iPAS | HESTIA | Morpheus

Boilerplate

Crew and Thermal Systems

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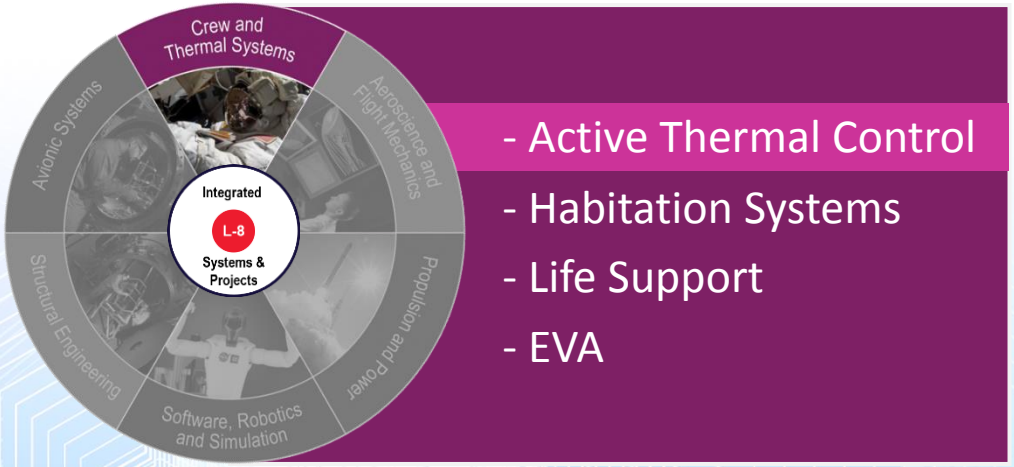

- Active Thermal Control
- Habitation Systems
- Life Support
- EVA

The Problem

- *Vehicle thermal control during ascent and descent phases has historically been achieved by venting a thermal control fluid of some kind.*
- *Eliminating consumable losses from the thermal control systems potentially reduces launch mass, resupply, and in situ resource utilization (ISRU) requirements for vehicles, while reducing the likelihood of forward planetary contamination.*

Non-Venting Thermal Control Systems for Space Vehicles – **Mars Surface Ascent/Descent**

- *Desired effort: identify candidate technologies capable of providing closed-loop thermal control through multiple ascents and descents of a single vehicle*
- *Develop a working prototype for feasibility evaluation at a NASA center*
- *Solution space is open*

Crew and Thermal Systems

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- Active Thermal Control
- Habitation Systems
- Life Support
- EVA

The Problem

- *Current space suit thermal control systems vent water at a rate of **~1 lb/hr**.*
- *Eliminating consumable losses from the space suit thermal control systems potentially reduces launch mass, resupply, and ISRU requirements.*
- *Current concepts pair venting systems with an absorber radiator to achieve near closed-loop operations.*

Non-Venting Thermal Control Systems for Space Vehicles – **Mars Surface Space Suits**

- *Desired effort: identify and develop closed-loop space suit thermal control technologies*
  - *Eliminate all venting associated with EVA thermal control*
- *Some preliminary ideas:*
  - *Thermal energy storage or utilization devices*
  - *Life support robotics*
  - *Flexible radiators*
- *Many extensions to terrestrial PPE*
- *Develop a working prototype for feasibility evaluation at a NASA center*
- *Solution space is open*

Current Concept/Technology Investments

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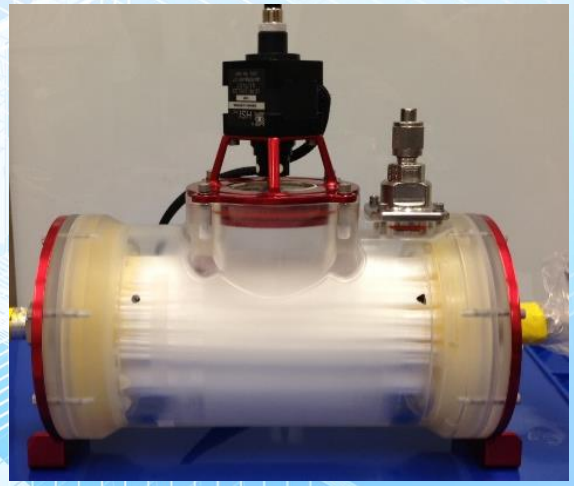
Phase Change Material Heat Exchanger

International Space Station Technology Demonstration

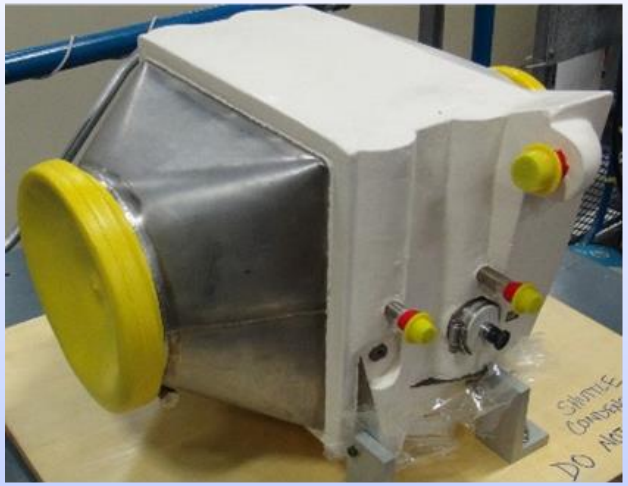


Space Suit Water Membrane Evaporator

Current Baseline for the Advanced Portable Life Support System

Shape Morphing Alloy Radiator Technology

Using Shape Memory Alloys to Provide Passive Radiator Turndown



Condensing Heat Exchanger Technology Development

Investigating Concepts to Improve System Performance and Lifetime

2016 Human Thermal Systems Roadmap Highlights

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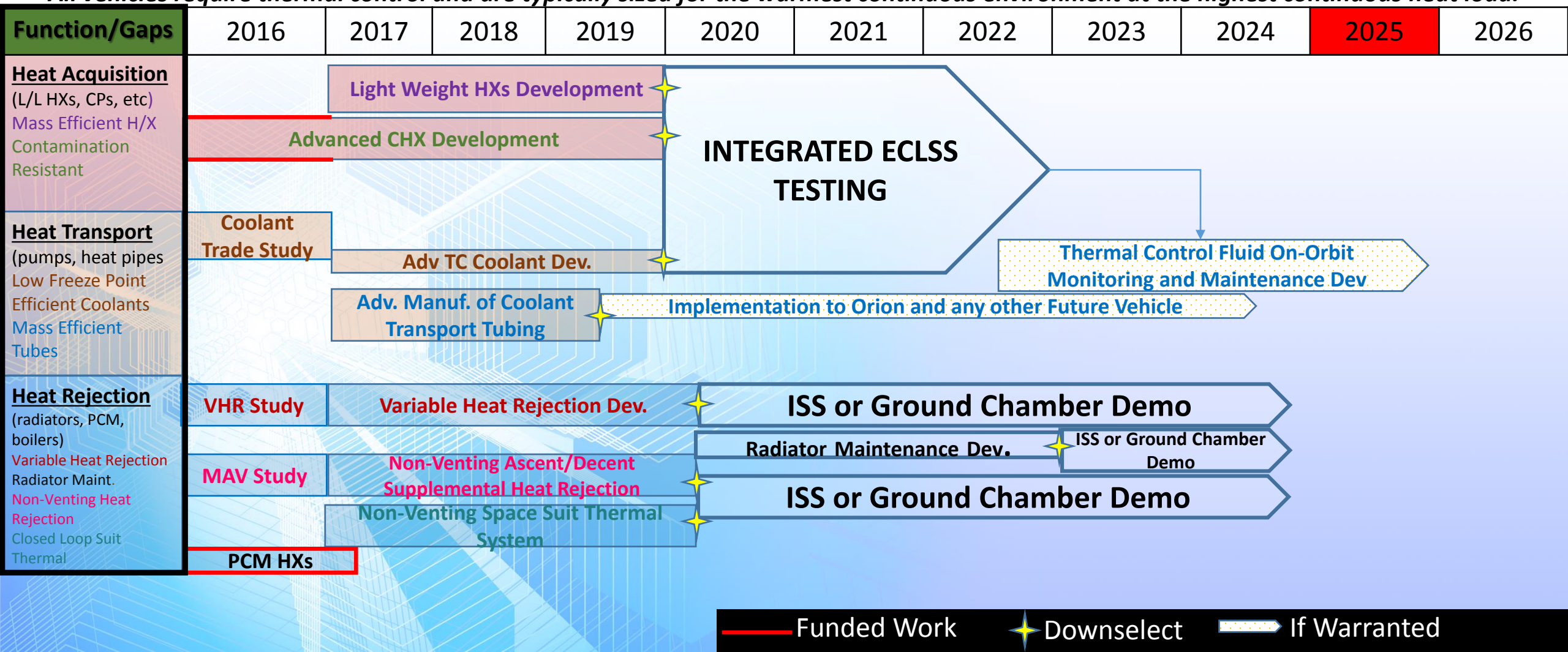
All vehicles require thermal control and are typically sized for the warmest continuous environment at the highest continuous heat load.



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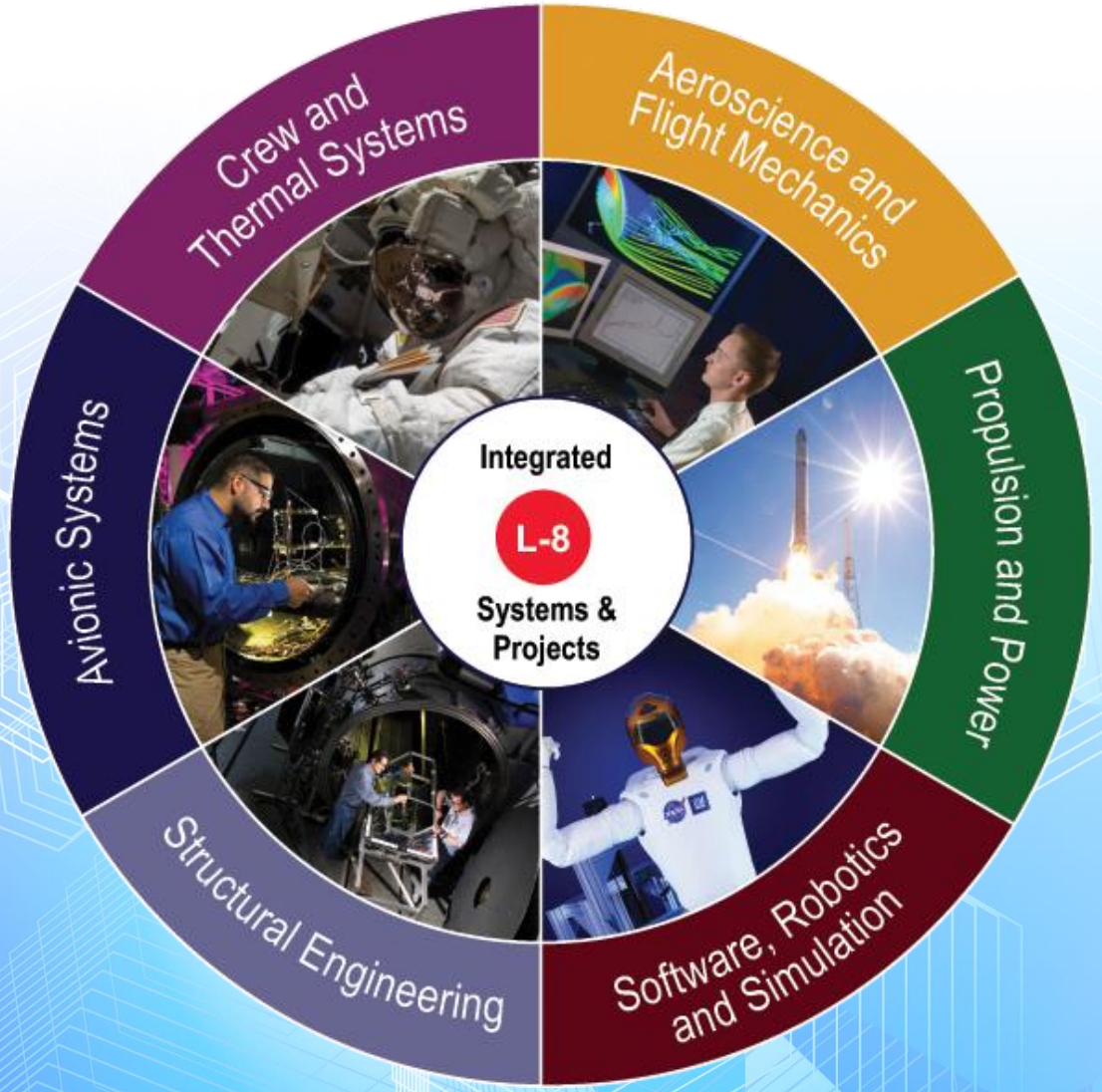

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  - Pointer to Co-Dev Announcements
  - Pointer to intake site

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