



2023 Artemis Crew Health and Performance (CHP) System Model Development

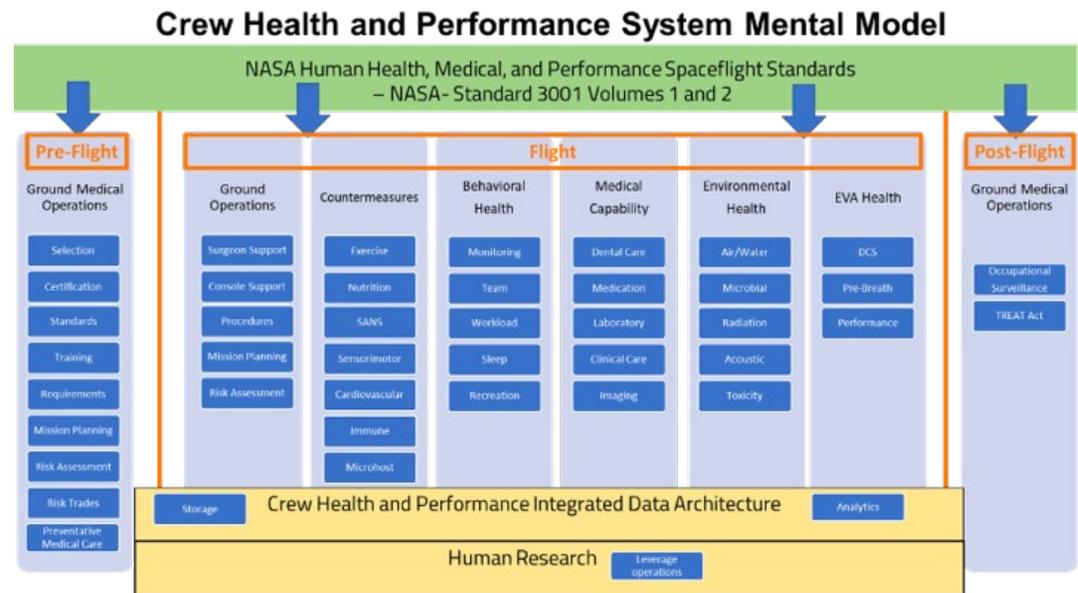
Human Research Program
Exploration Medical Capability Element

HRP IWS
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Michael Krihak, PhD, Chris Laing, John Odina

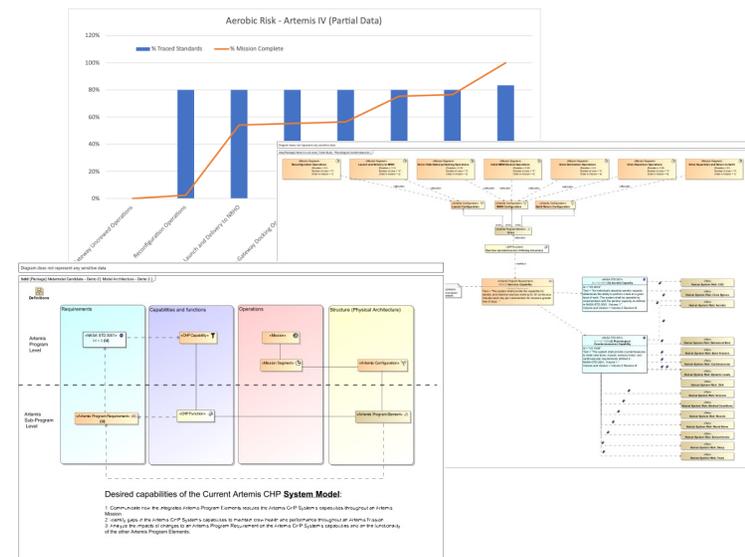
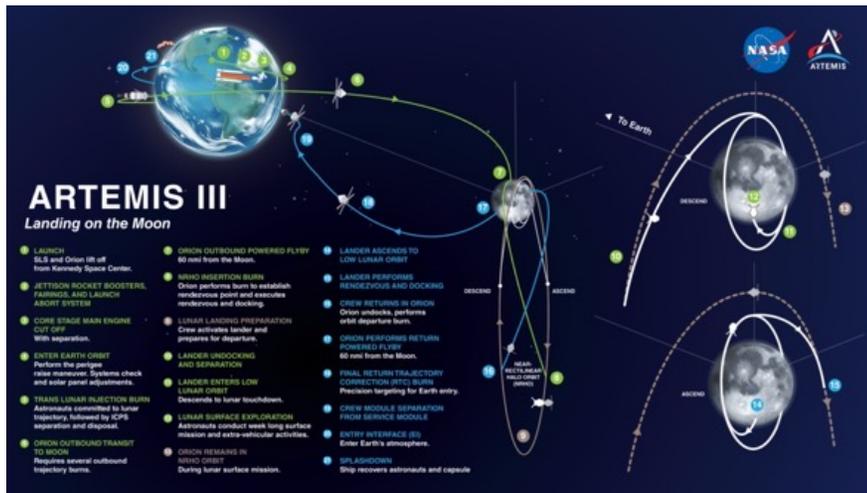
“Expanding the Boundaries of Space Medicine and Technology”

- The Human Research Program (HRP) recommends the use of a CHP mental framework to facilitate the integration of functions and capabilities across a human exploration mission:
 - How will exercise countermeasures be provided across multiple vehicles?
 - Will adequate sleep accommodations be provided in every environment?
 - How will radiation exposure be monitored for each crew member across the mission?
- The CHP mental model may be used at the mission level or tailored for the development of an individual vehicle or habitat.



Purpose:

Create a system model that allows a user to visualize and analyze the overarching CHP system used throughout a crewed Artemis mission.





Goals and Objectives



Project Goal:

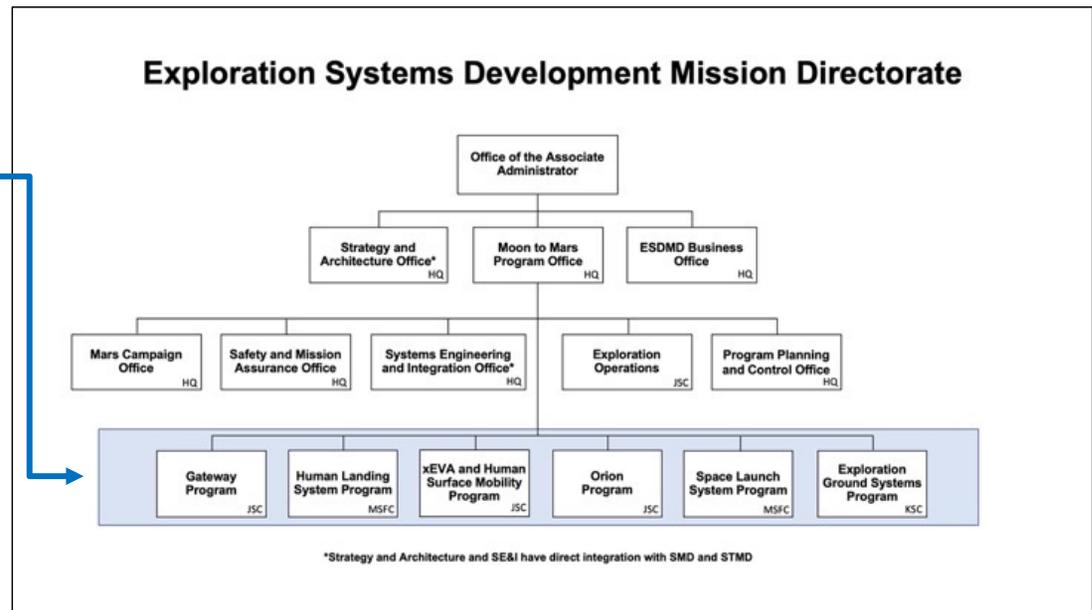
Provide a Crew Health and Performance System Model that can identify both connections and inconsistencies related to CHP across an entire Artemis Mission.

Project Objectives

- Create a CHP System Model for Artemis III and IV which can be expanded for later missions.
- Models can be used by main stakeholder groups such as a Chief Health and Performance Officer (Health and Medical Technical Authority (HMTA)) or a Gateway/Human Landing System (HLS) CHP System Manager (Human Health and Performance (HH&P)).

Assumptions

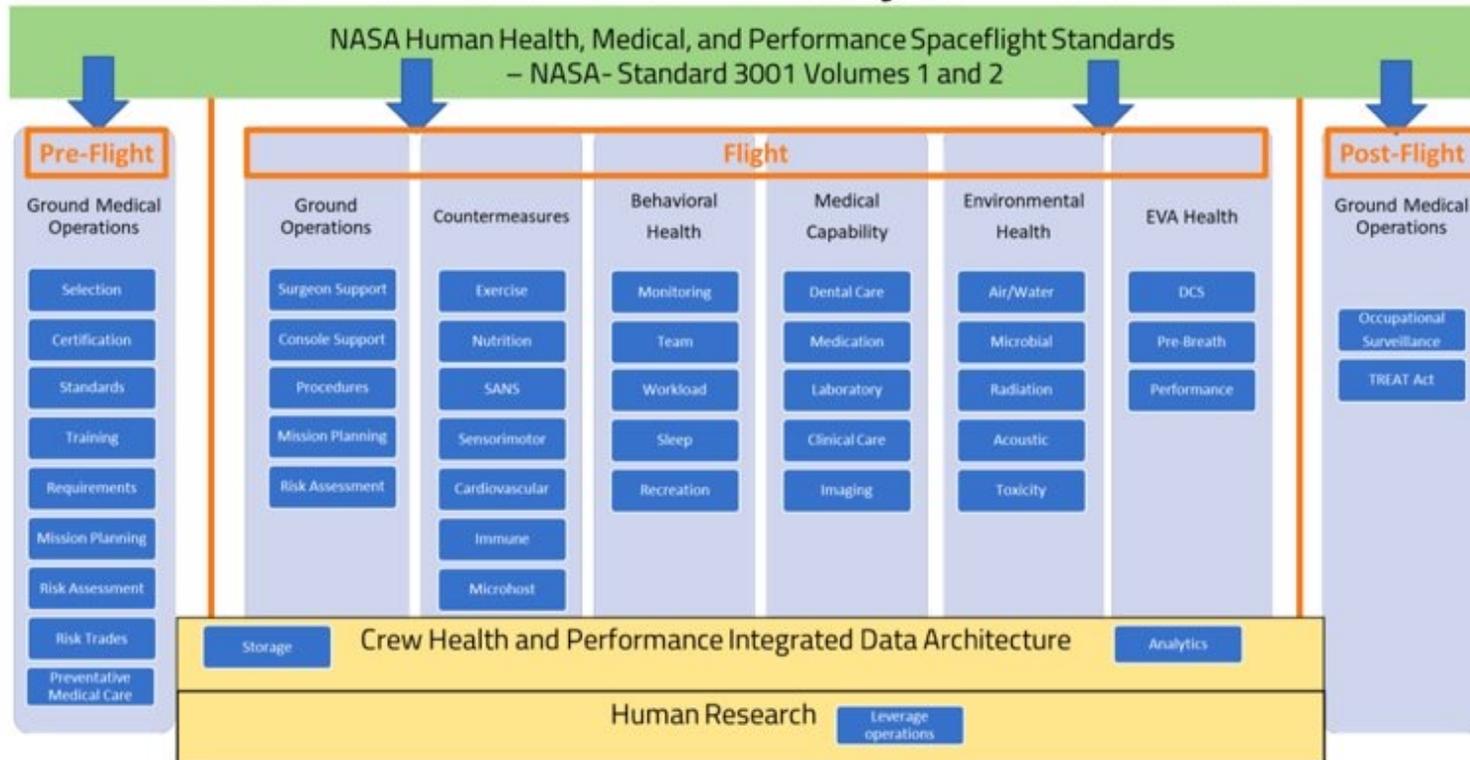
- **Project focus on the following programs:**
 - Gateway
 - Human Landing System (HLS)
 - Orion
 - Extravehicular Activity and Human Surface Mobility (EHP)
- **The project incorporates only requirements from above programs, the Moon to Mars program office and existing NASA Standards.**
- **Only the launch to landing portions of an Artemis mission are included in model.**



- **Apply Model-Based Systems Engineering (MBSE) principles and tools to develop the relationships among standards, risks, CHP capabilities and Program requirements.**
- **Pull data from each of the Program's digital repositories.**
- **System model created agilely averaging two demos per month to internal NASA stakeholders.**
- **Additional data, relationships and views added to model based on demo feedback.**

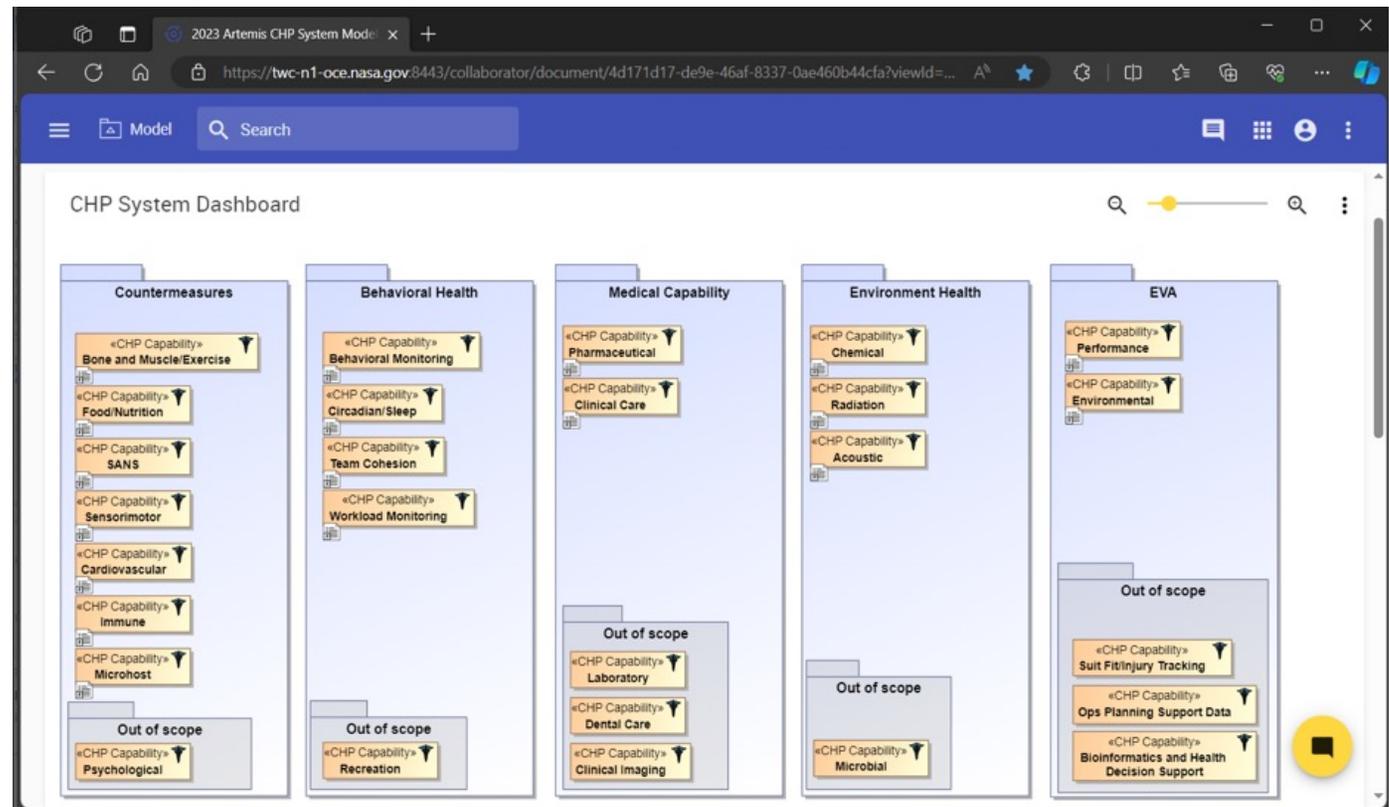


Crew Health and Performance System Mental Model

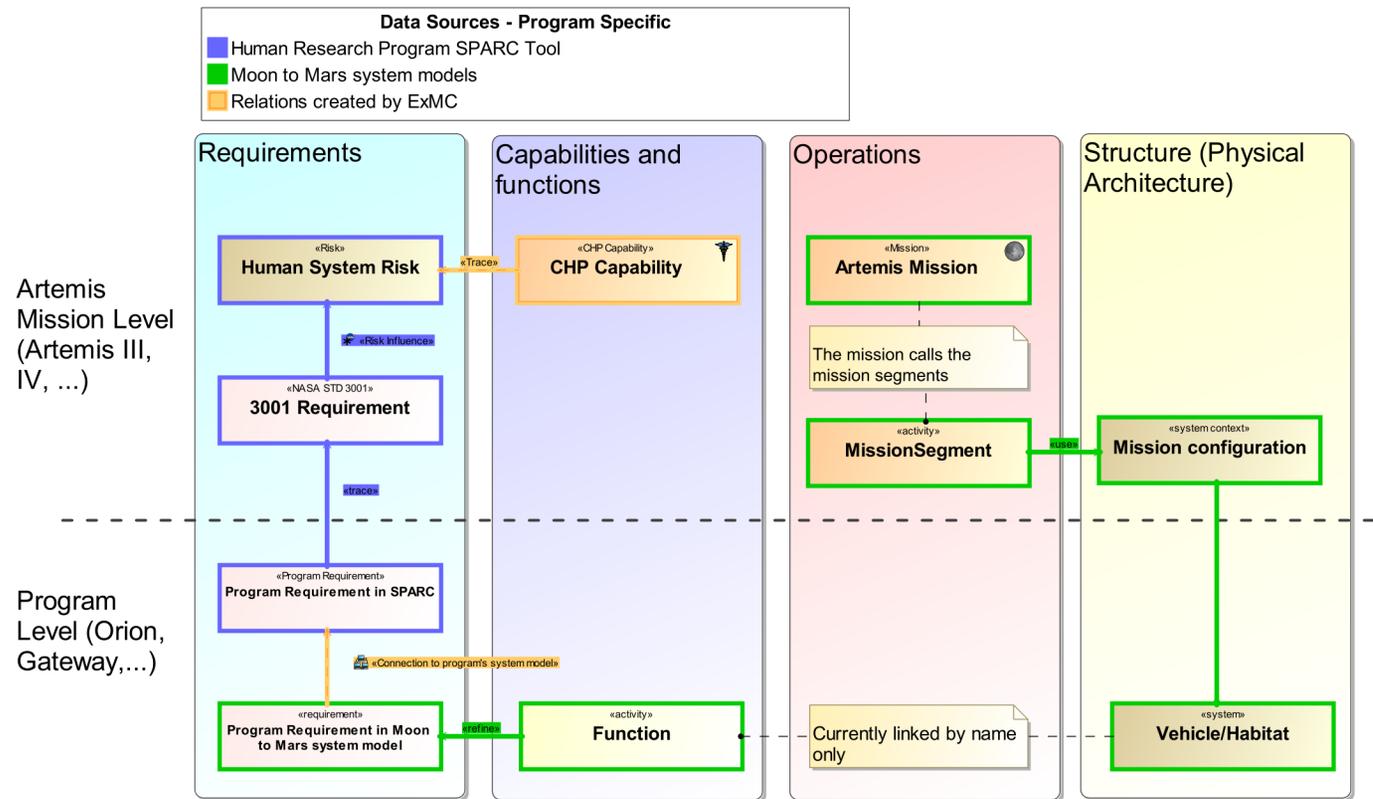


Prototype model:

- Interactive CHP system dashboard
- Available to NASA users as a browser-based application.
- User can drill down on each CHP Capability to see how it is achieved during an Artemis Mission.



- Current model is representative of Artemis III and IV.
- Architecture can expand for succeeding Artemis missions.
- Data behind dashboard is pulled from source of truths.
- Available CHP data increases as programs continue to develop.



Food/Nutrition CHP Capability

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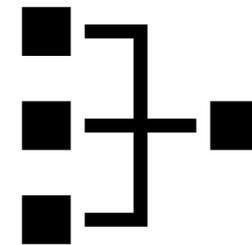


Untraced Standards - Artemis III

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#	Mission Segment	Allocated to	Number of 3001 Volume 2 Requirements Related to Mission Segment (Revision A and B)	3001 Volume 2 Standards Related to Mission Segment Not Traced to a Program Requirement (Revision A and B)
1	Launch and Delivery to NRHO	Launch Configuration-A (DRM A)	59	<ul style="list-style-type: none"> (U) V2 6035 Suited Operations Water Quantity (U) V2 6041 Hot Beverage Water Temperature (U) V2 6042 Cold Beverage Water Temperature (U) V2 6043 Food Hydration Water Temperature (U) V2 7002 Food Acceptability (U) V2 7007 Food Microorganism Levels (U) V2 8003 Volume for Mission Accommodation
2	Initial Approach, Rendezvous, Proximity Operations, and Docking (IRPOD)	ACDD 4.3 Post-TLI Configuration - ArtIII (DRM A)	59	<ul style="list-style-type: none"> (U) V2 6035 Suited Operations Water Quantity (U) V2 6041 Hot Beverage Water Temperature (U) V2 6042 Cold Beverage Water Temperature (U) V2 6043 Food Hydration Water Temperature (U) V2 7002 Food Acceptability (U) V2 7007 Food Microorganism Levels (U) V2 8003 Volume for Mission Accommodation
3	Initial NRHO Docked Operations	NRHO Configuration-A (DRM A)	120	<ul style="list-style-type: none"> (U) V2 7001 Food Quality

- **A Chief Health and Performance Officer, Crew Health and Performance system manager or researcher could use the system model to:**
 - Analyze how a NASA Spaceflight Human System requirement is flown down and across the Artemis mission: *What will the vehicles and habitats do to limit lunar dust contamination during Artemis III?*
 - Analyze the impact to the overall mission after changing an individual program requirement: *Are docked vehicle's capabilities affected if my program's food preparation requirements are changed?*
- **The 2023 Artemis CHP system model is a descriptive model.**
 - It can query the existing requirements and connections.
 - It does not perform calculations or run simulations.



- **The project team's modeling efforts and discussions with key stakeholders helped to reveal:**
 - Pertinent CHP requirements, relations and architecture is siloed between different data sources. As of today, an integrated model such as ExMC's Artemis CHP System Model, is needed to connect these sources to enable CHP views across a mission.
 - Currently available system engineering data does not routinely highlight when one vehicle requires another vehicle's presence to achieve its CHP capabilities (borrowed capabilities).
 - The implementation of CHP capabilities using Government Furnished Requirement (GFE) is sometimes omitted in the available system models. (Such as portable equipment that follows the crew during the mission).



- The ExMC 2023 Artemis CHP system model assists CHP system managers and medical officers quickly find CHP system engineering data available from existing digital engineering environments.
- If the current prototype system model is verified for operations, it could help analyze and integrate CHP functions across future Artemis missions.
- The system model is available to users with NASA VPN access upon request to ExMC.
- The proposed CHP system representation and expanded data contributes to NASA's Human Research Program (HRP) goal of aligning with stakeholders via a CHP Framework.

