

Reference Surface Activities for Crewed Mars Mission Systems and Utilization

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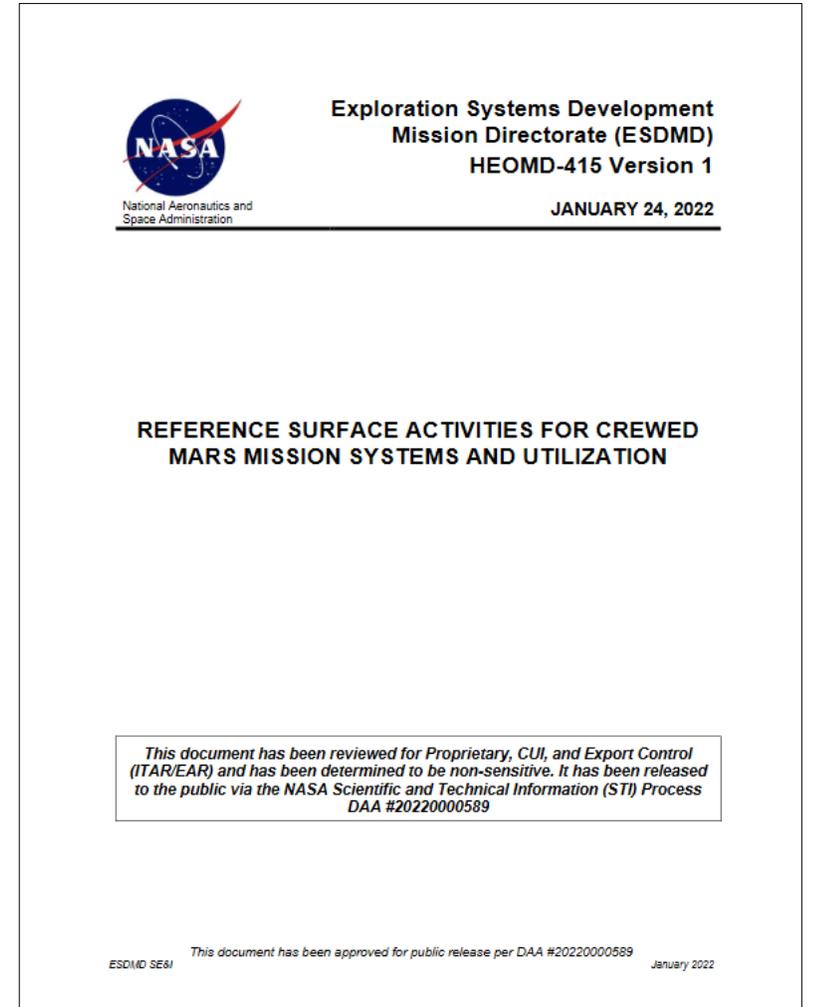
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Background

- On-going analyses of human Mars mission architectures – and specifically the Mars surface mission – indicated the need for a more detailed description of crew activities and time allocations for each of those activity types
- The architecture being studied by NASA during 2019-2021 was used as the basis for the document – ***no final decision has been made by NASA for the human Mars mission architecture; this is one option being used for analysis and trade studies***
- This work has been documented in HEOMD-415
 - <https://ntrs.nasa.gov/citations/20220000589>
- The resulting timeline analysis factored in assumptions for:
 - Crew capabilities and limitations
 - Surface systems infrastructure and constraints
 - Maintenance and logistics
 - Relevant Martian environmental considerations



Current HEOMD-415 Document Content

- **Current document content includes:**

1. Summary description of the architecture option studied by NASA during 2019-2021, including:

- Mission profile
- Mission goals and objectives

2. Assumptions related to:

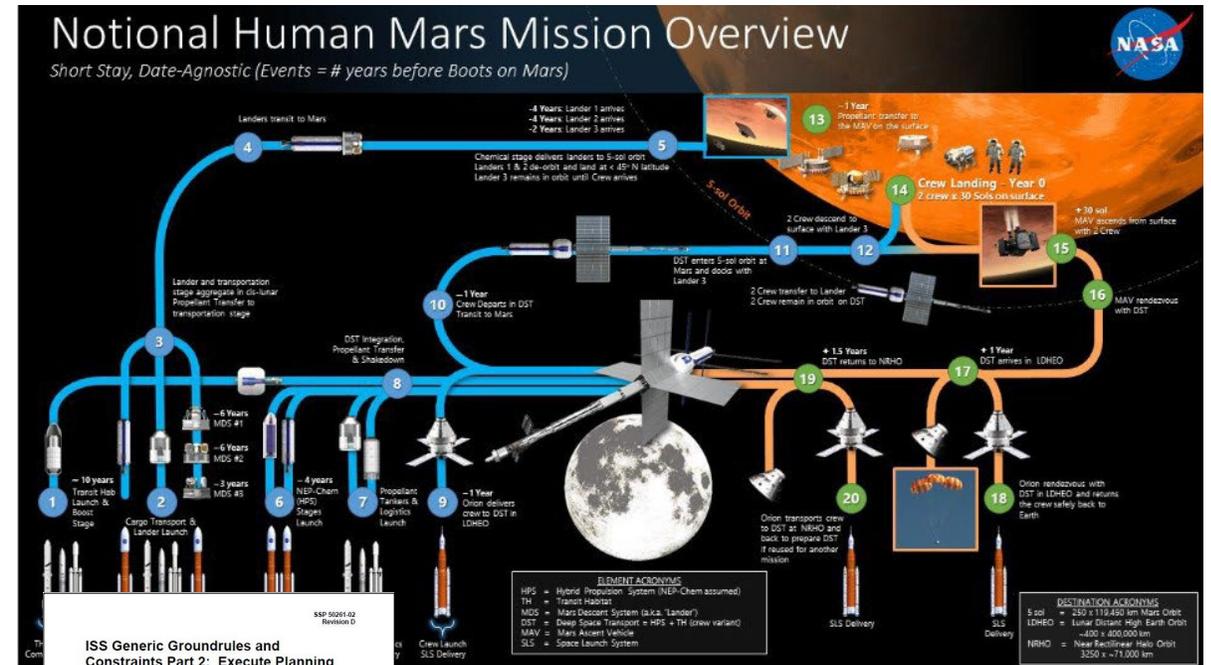
- Overall timeline planning
 - ISS crew planning guidelines are the basis for non-utilization activities

- Crew care
- Equipment care

1. 30-sol surface mission timeline

- *This is considered a minimum duration for the surface mission*

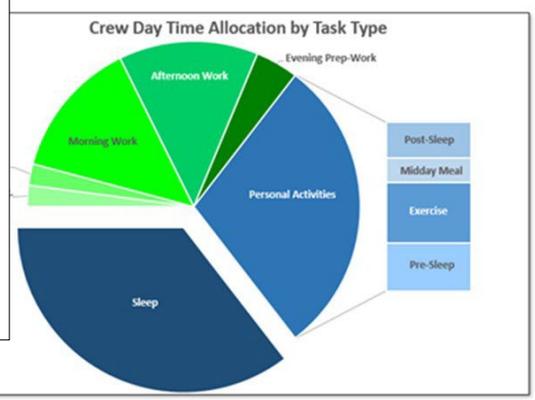
2. An extended surface mission timeline for comparison purposes



ISS Generic Groundrules and Constraints Part 2: Execute Planning
Revision D
Incorporates SSCD 16104
November 2012

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National Aeronautics and Space Administration
International Space Station Program
Johnson Space Center
Houston, Texas



Activity	Hours
Sleep	8.50
Post-Sleep	1.50
Daily Planning Conference	0.50
Morning Prep-Work	0.50
Morning Work	3.25
Midday Meal	1.00
Afternoon Work	3.25
Evening Prep-Work	1.00
Exercise	2.50
Pre-Sleep	2.00
Total	24.00

Category Totals:

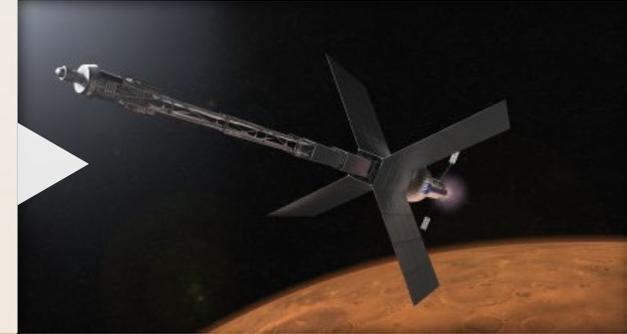
Personal Activities	7.00
Sleep	8.50
Conferences, Prep	2.00
Available Work Hours	6.50



Notional First Human Mars Mission Described in HEOMD-415

TRANSIT HABITAT (TH) AND HYBRID NUCLEAR ELECTRIC PROPULSION (NEP) / CHEMICAL STAGE

- Supports four crew on the long mission to Mars
- Two crew remain in orbit while two crew visit the Mars surface



1

PRE-DEPLOYED CARGO

- 25-ton class payload Mars lander
- Ascent vehicle propellant, Fission Surface Power, and surface mobility/propellant transfer system



2

PRE-DEPLOYED CREW ASCENT VEHICLE

- Partially-fueled



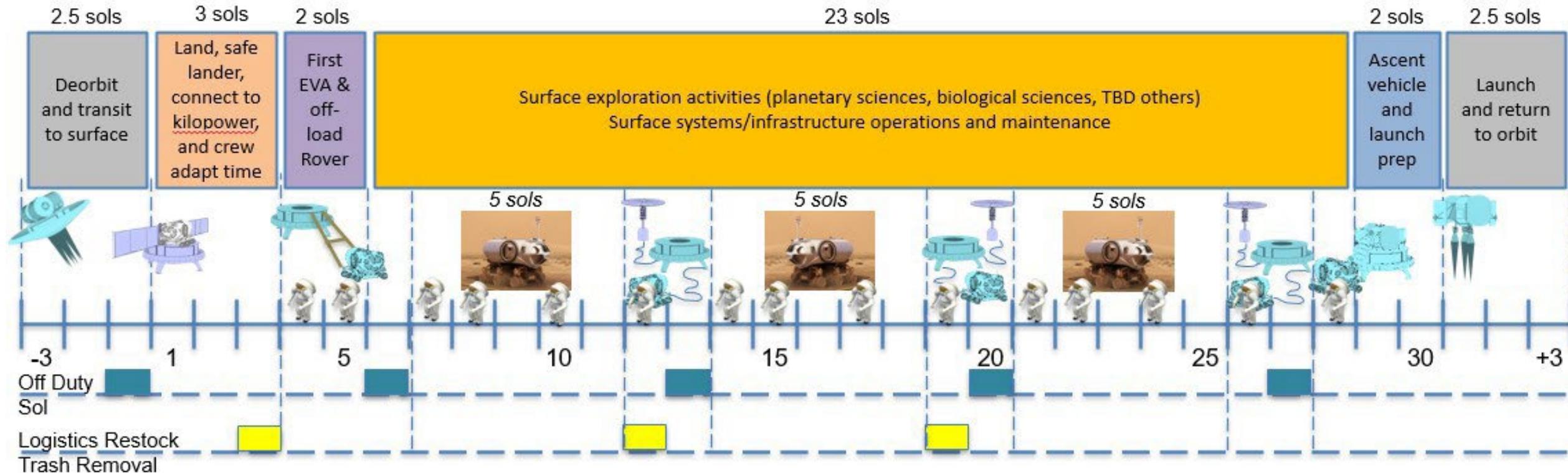
3

CREW

- Two crew land/live in pressurized rover
- Provides habitation and mobility for 30 days
- Supports science and exploration operations



30-sol Surface Mission Timeline*



This short-stay mission reference timeline was developed to anchor surface operations analysis, in particular to understand how much time would be available for science and exploration after partitioning out anticipated crew and equipment care allocations. Again, this timeline should not be misconstrued as “the plan.”

* “Reference Surface Activities for Crewed Mars Mission Systems and Utilization” (HEOMD-415) <https://ntrs.nasa.gov/citations/20220000589>

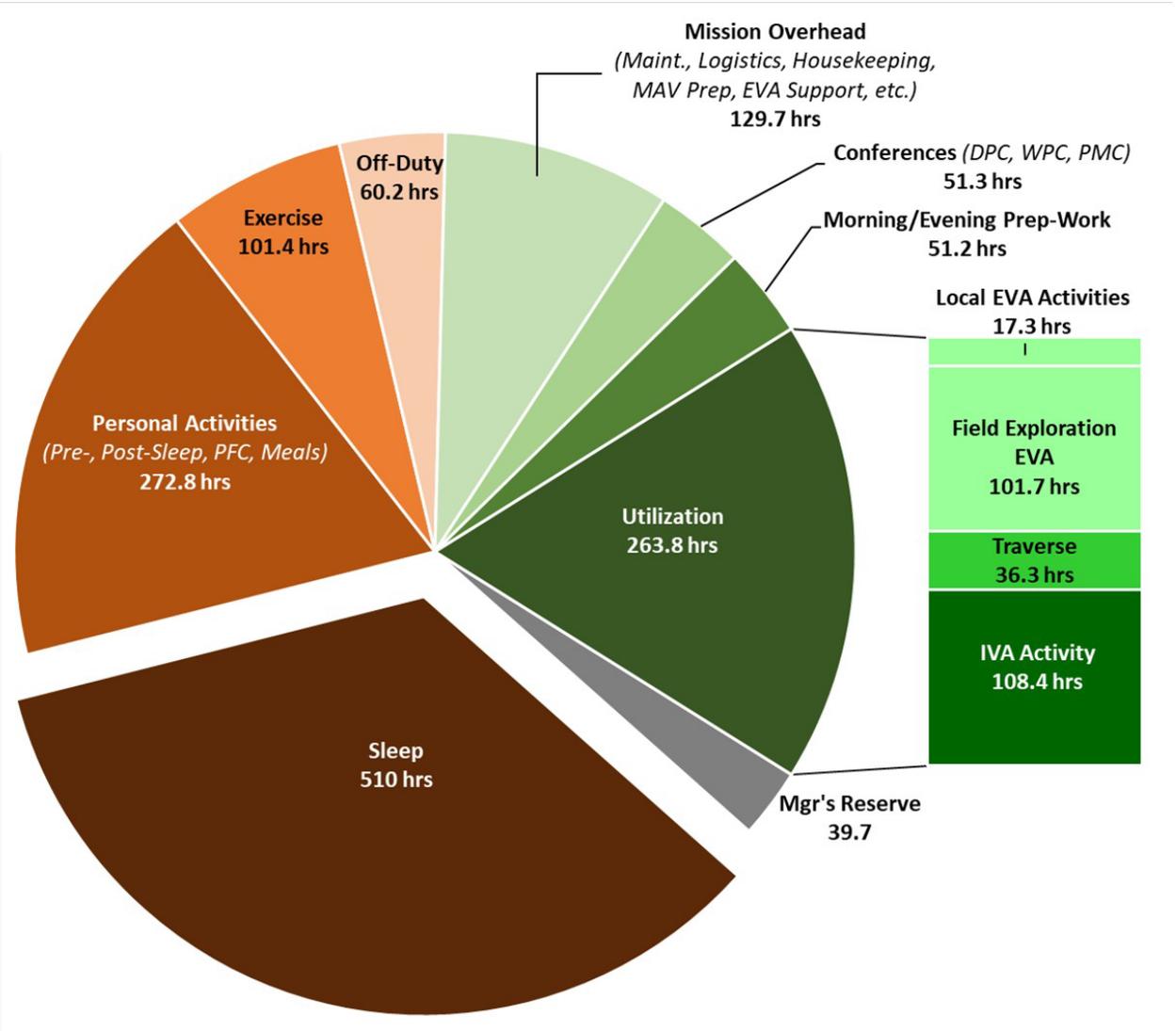


30-sol Surface Mission Crew Time Allocation

Task Time Roll-Up (2 Crew)

Total Time on Surface: 30 sols (740 hours)
1,480 total crew-hrs

Category	Task	Task Hrs	Category Hrs
Mgr's Reserve			39.7
Utilization	Local EVA Activities	17.3	263.8
	Field Exploration EVA	101.7	
	Traverse	36.3	
	IVA Activity	108.4	
Morning/Evening Prep-Work	Morning Prep-Work	15.7	51.2
	Evening Prep-Work	35.5	
Conferences	Private Medical Conf. (PMC)	15.2	51.3
	Weekly Planning Conf. (WPC)	6.7	
	Daily Planning Conf. (DPC)	29.5	
Mission Overhead	Housekeeping	24.0	129.7
	MAV Prep	30.2	
	Safe Lander	4.0	
	EVA Logistics	8.8	
	IVA Logistics	2.7	
	Suit Adjustment	16.7	
	Enter PR	16.7	
	Exit PR	25.7	
	EVA Prep	1.0	
	EVA Support	-	
	Enter Hab	-	
	Exit Hab	-	
	Off-Duty		
Exercise	Exercise-Short	30.0	101.4
	Exercise-Long	71.4	
Personal Activities	Private Family Conf. (PFC)	2.8	272.8
	Pre-Sleep (incl. Meal)	120.0	
	Post-Sleep (incl. Meal)	90.0	
	Midday Meal	60.0	
Sleep			510.0
TOTAL Hours			1,480.0



30-sol Surface Mission EVA Time Summary

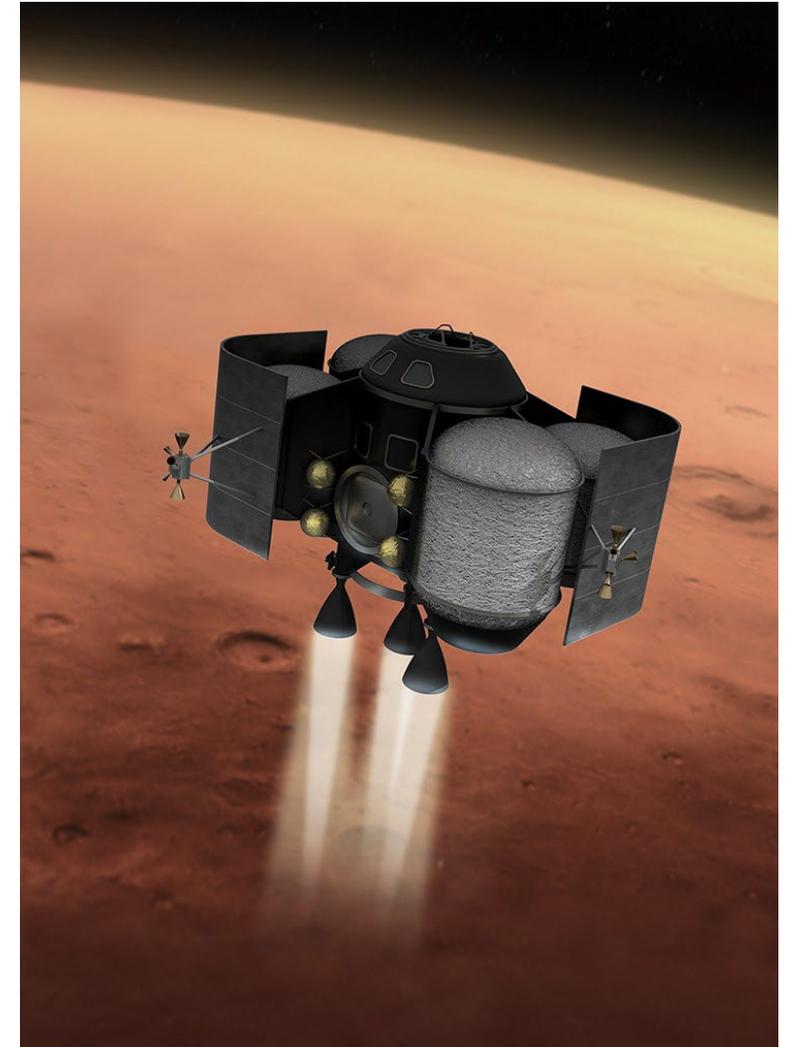
Sol Number	Number of EVAs		EVA Hours (Morning / Afternoon)		Total EVA Hours	Description
	Crew 1	Crew 2	Crew 1	Crew 2		
1 - 3	0	0	0	0	0	Crew acclimate
4	2	2	2.5 / 4	2.5 / 4	13	First EVA, PR depress and crew egress through side hatch
5	2	2	2.5 / 1.5	2.5 / 1.5	8	Off-load PR and deck cargo
6	0	0	0	0	0	Off-duty
7	1	1	0 / 2.5	0 / 2.5	5	Traverse to Site 1; field exploration/initial recon
8	2	2	2 / 2.5	2 / 2.5	9	Field exploration
9	0	0	0	0	0	Field exploration; IVA only
10	2	2	3.5 / 2.5	3.5 / 2.5	12	Field exploration
11	0	0	0	0	0	Return to cargo lander; housekeeping
12	1	1	2 / 0	3 / 0	5	Logistics restocking and trash removal
13	0	0	0	0	0	Off-duty
14	1	1	0 / 2.5	0 / 2.5	5	Traverse to site 2; field exploration/initial recon
15	2	2	3.5 / 3	3.5 / 3	13	Field exploration
16	0	0	0	0	0	Field exploration; IVA only
17	2	2	3.5 / 2.5	3.5 / 2.5	12	Field exploration
18	0	0	0	0	0	Return to cargo lander; housekeeping
19	1	1	2 / 0	3 / 0	5	Logistics restocking and trash removal
20	0	0	0	0	0	Off Duty
21	1	1	0 / 2.5	0 / 2.5	5	Traverse to site 3; field exploration/initial recon
22	2	2	3.5 / 3	3.5 / 3	13	Field exploration
23	0	0	0	0	0	Field exploration; IVA only, no EVA
24	2	2	3.5 / 2.5	3.5 / 2.5	12	Field exploration
25	0	0	0	0	0	Return to cargo lander; housekeeping
26	2	2	3.5 / 3	3.5 / 3	13	Local EVA at landing site
27	0	0	0	0	0	Off Duty
28	1	1	3 / 0	3 / 0	6	Utilization EVA: sample packaging, external MAV prep, etc.
29 - 30	0	0	0	0	0	Traverse to MAV location and dock; prep MAV for launch
Conting.	1	1	4 / 0	4 / 0	8	Contingency EVA
Total	25	25	39 / 32	41 / 32	144	

- HEOMD-415 (from which this table is extracted) acknowledges that Mars EVA equipment details are still conceptual
- Assumptions used to build EVA frequency and duration are based on experience with past and current EVA systems
 - Crew will have at least one non-EVA sol between EVAs wherever possible
 - Where EVAs on consecutive sols are difficult to avoid, exceptions are made but the total EVA duration across consecutive sols is reduced as much as possible
- Suitports are assumed as primary means if ingress/egress; no airlock is included
- EVA maintenance divided into simple, more frequent maintenance tasks and more extensive, less frequent tasks
 - Simple maintenance includes cleaning/drying internal surfaces of the suit and checkout / preventative maintenance of PLSS (portable life support system) components
 - More extensive maintenance includes replacement of suit components known to wear out with repeated use (e.g., gloves, boots, batteries, etc. after no more than 24 EVA hours)



30-sol Surface Mission Returned Payload

- **Each kilogram returned to orbit around Mars has one of the highest “multipliers” of any element of a Mars mission**
 - Each returned kilogram requires propellant to reach orbit, which in turn requires transportation from Earth, which in turn ...
- **This 30-sol scenario assumes that 100 kg of sample-related payload will be returned to orbit**
 - This includes all containers, environmental control equipment (e.g., freezers), etc.



Summary

- **NASA is currently looking at scenarios for the first human Mars mission**
 - Any subsequent human Mars mission(s) are assumed to build on these capabilities and operations
- **This first mission scenario envisions sending two crew to the surface of Mars for a period of 30 sols – *no final decision has been made by NASA for the human Mars mission architecture; this is one option being used for analysis and trade studies***
- **Estimates have been made for the amount of time available to the crew for utilization activities**
 - Approximately 18-20 percent of the total crew hours on the surface are available for utilization (e.g., science) activities
- **Current manifests allow for 1000 kg of utilization payload to be delivered to the surface**
 - This does not include other assets, such as power and rovers, that can support utilization
- **Current capabilities allow for 100 kg of utilization payload to be returned to orbit**
- **See HEOMD-415 for additional details**
 - <https://ntrs.nasa.gov/citations/20220000589>

