# Expertise and Training Considerations for Crew Complement to the Mars Vicinity

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*Abstract* – **As the National Aeronautics and Space Administration and the public eye turn their sights to human-crewed mission to Mars, determining the capabilities needed by a crew to complete a Mars mission has started to become an important consideration. With the potential of a 22-minute communication delay each way and a three-week blackout period, a greater need has developed for crew autonomy and independent operation. Studies have been conducted to lay the framework for how to examine the impact of crew size on crew qualifications and responsibilities, and analyses have refined this trade space for a Mars Surface crew, but there is a need to analyze the Mars on-orbit crew and as well as the entire crew to the Mars vicinity. The aim of this report is to combine previous efforts to examine the trade space for a Mars expedition based on the expertise and personnel required for Earth-independent operations.**

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## 1. Introduction

As the National Aeronautics and Space Administration plans for crewed Mars missions, it is necessary to understand the capabilities needed of a crew when handling a large communication delay and Earth independent operations. All space operations up until this point have always had the backing of an Earth-based Mission Control Center (MCC) that performs the majority of mission operations. Mission and EVA planning, system monitoring, support operations, and more have always been controlled by an MCC, which is a luxury that a Mars crew will not be able to afford for tasks requiring real-time support. The Mars crew will need to be able to perform their own autonomous operation without the real-time support of a MCC to address time critical events and emergencies, necessitating a new, higher level of expertise. Though many have theorized possible crew sizes to support Mars expeditions, there has never been a concrete accepted answer [1]. This is primarily because there has never been a real expedition for human crews to reach the red planet. But now as NASA sets its sights further than ever before, there is a need to make architecture decisions on how many crewmembers will be sent to Mars. Efforts have been conducted to study what a crew on the surface would need, but it needs to be expanded to include the support necessary on orbit and thus the entire Mars vicinity. By looking at the expertise required of an on-orbit crew, it is possible to home in on a range of crew sizes to support a Mars expedition. Workload will not be used a driver in this analysis, only the expertise and responsibilities required to support an expedition.

## 2. Size Considerations

When beginning to look at the size of a crew necessary for a Mars mission, an important study was conducted that laid groundwork for the necessary capabilities of the crew. An effort from the NASA Engineering and Safety Center (NESC) created a systematic methodology focused on aiding the determination of crew sizes for crewed Mars missions [2]. The driving force behind this effort was the communication delay of up to 22 minutes each way between Mars and Earth and the blackout period that occurs during superior conjunction. If an unforeseen, short time-to-effect event was to occur, it would not be possible to rely on a MCC to provide support and solutions like is done in current mission architectures. This creates the need for a crew that can perform Earth-independent operations without the support of a MCC or its auxiliaries to handle these situations, which also means the crew will need to be trained to a higher level to prepare for these scenarios. This study resulted in four primary models that can be used to develop a Mars crew size, but the most important of these for human systems integration considerations is the Personnel, Expertise, and Training (PET) Model.

The PET Model focuses on examining crew size implications through focusing on the level of expertise necessary for nominal operations and to respond to unforeseen circumstances [2].

The NESC report also included recommendations for the maximum number of responsibilities a crewmember could be trained to the highest qualification level, and recommendations of possible groupings of vehicle core systems based on discussion with subject matter experts. However, after additional discussion with Subject Matter Experts (SMEs), these groupings were tweaked slightly. For the Mars orbit crew, the groupings of vehicle core systems that were considered acceptable by operations SMEs for a single crewmember to be trained to the highest level of qualification are as follows:

- ECLSS + TCS
- CDH with LAN + C&T + EPS
- MCS + Prop

These pairings served as basis for responsibility assignments and were followed closely to avoid training overload in crewmember assignment. ECLSS & TCS were paired together because these core systems involve fluid and fluid dynamics, making them the most compatible. CDH, C&T, and EPS were grouped because these systems involve electrical systems and data flow. MCS and Prop were grouped together because these systems involve the vehicle's dynamics and control.

Additionally, this report laid out potential training hours for all specialist and operator positions using data from ISS and SpaceX Dragon training flows. Lead hours were created through interviews with SMEs. MPSR flight controller training hours were determined to be an appropriate estimate for the hours required for transit habitat core system Lead qualifications.

At the same time, a team within NASA began a detailed effort to study the expertise requirements that the crew would need on the

Mars surface [3]. The aim of this study was to examine the tradespace for various crew sizes and Mars surface architectures, with a focus on the minimum expertise necessary for a team on the surface. This study focused on a Crew Qualifications and Responsibilities Matrix (CQRM) for the surface crew.

The results of this approach showed that, given multiple assumptions aimed at minimizing surface crew sizes, 3 crew would be the minimum size crew that could be trained to have all required qualifications within a 2-year training flow. Larger crews were able to have redundant qualifications as well as enable the addition of other surface elements. The surface crew would encompass all aspects of using the Mars Descent Vehicle (MDV), Mars Ascent Vehicle (MAV), operating the habitat, and day to day operations on the surface. Critically, this approach assumed that there would be some level of support within the Mars vicinity for EVAs and other tasks, with impacts to the size of the on-orbit crew.

By using the data and analysis from both habitats, an effort to size the capabilities for the Mars vicinity and transit habitat crew was undertaken. The results of this effort are described in this paper, as well as the consequences that the larger crew will have on transit habitat development. It will additionally be compared to other models and estimates on the capabilities required to support a Mars crew to highlight gaps in the current framework that must be addressed before a mission can be made possible.

## 3. Methods

The primary approach of this analysis was to combine the efforts from the Mars Architecture study within NASA with the findings from NESC to size what capabilities were required in the Mars vicinity. This was done by integrating a CQRM with the PET Model to lay out the expertise required for all crew responsibilities in the Mars Transit Habitat (MTH).

The responsibilities outlined for the MTH crew for each position are as follows: Operator, Specialist, & Lead. An operator has the capability to live safely on-board the vehicle and to respond to a warning event to safe a system, operation, or payload using published procedures. This includes but is not limited to emergency response for each vehicle and all habitability duties for each vehicle. A specialist has the capability to perform all operator duties and has sufficient knowledge to be capable of responding to a caution event for a system, operations, or payload using published procedures. A lead has the capability to perform all specialist duties and has sufficient knowledge to be capable of working outside the scope of procedures to meet primary mission objectives and to respond to off-nominal events and unforeseen failures for a system, operations, or payload. [2]

The core systems outlined for the MTH are the ECLSS, TCS, MCS, Prop, CDH with LAN, C&T, and EPS. These systems at the minimum need one lead to perform necessary duties. Additionally, there must be two Emergency Operations Leads, two Medical Operation Leads, a minimum of three EVA Support Leads, and two EVA Hardware & Task Leads.

The EVA Support Lead is a new Mars crew qualification level and responsibility. The EVA Support Lead is responsible for real-time EVA coordination with the capability to respond to unforeseen failures with short time-to-effect that may lead to loss of crew/loss of mission scenarios. The EVA Support Leads would be responsible for supporting any transit habitat microgravity EVAs as well as supporting all surface crew partial gravity EVAs. Previous analysis had shown that two crew members would be overloaded if attempting to perform the key MCC duties required for an EVA. For this analysis, it was assumed that three crew members would be adequate to perform these tasks.

A priority was placed upon redundant leads for all core systems besides MCS & Prop. EVA Support lead redundancy was also prioritized. These core systems were prioritized because they are time critical should a failure occur, and the EVA Support leads were prioritized to facilitate the capability of daily EVAs, if necessary.

There are also many required specialist positions which were evenly distributed among the crew to bring them to a uniform amount of training hours. If assigning a secondary lead to a core system was not possible, it was desired to have a secondary specialist instead.

It was desired to keep certain groupings of responsibilities together. The recommended groupings from the SMEs were followed whenever possible. Additionally, the MTH Commander responsibility was also paired with an Emergency Operations Lead.

For the purpose of analysis, core systems leads were the primary focus as they entail the largest training load upon crewmembers.

A CQRM was then filled out for the level of expertise necessary for the habitat. Different assumptions were used to influence the sizing to give a range of recommended crew sizes. The CQRM ensured that all critical responsibilities were filled, and that each crewmember would stay within the allotted two years of training hours. The maximum training hours were derived the NESC report which were from trends seen on ISS where after two years knowledge retention decreases [2].

## 4. Assumptions

Some assumptions were made for the purpose of simplifying decisions on crew expertise. The first assumption was the improvement of core systems and subsystems for increased automation and simplification of crew processes and responsibilities. By the time of a crewed Mars expedition, it is reasonable to assume that technological innovations and improvements in spacecraft architecture will allow for the automation of many processes within the overall mission operation to reduce the need for human monitoring of systems and decrease the number of overall positions a crewmember would need to be trained to. Importantly, it was assumed that the on-board information architecture would support in-depth troubleshooting to allow the crew to respond to unforeseen events.

The next major assumption was the existence of a deep space communication network to support continuous time-delayed transmission from Earth to Mars. This assumption allows support from a MCC on tasks and information that is not time critical. Time delays will still exist as described with this network, but it does bring the delay to a minimum by having the fastest communication possible. Without this continuous communication capability, the Mars crew members may need to be trained to an even higher level, as they will be required to fully solve issues and not just extend the time-to-effect until MCC resources could be employed.

A communication network supporting continuous, near real-time communication between the MTH and the Mars surface crew is also assumed. This network is what allows the MTH EVA Support leads to provide support to the surface crew. Without this continuous communication capability, the split of responsibilities for EVA Support leads between the MTH and surface crew would need to be reexamined.

Additionally, it is assumed that workload is of minimal consideration for this analysis. While workload is evaluated to some extent by following the responsibility grouping recommendations of the SMEs, the full extent as to which these positions have on the daily workload and schedule is unknown. Although workload could impact crew size requirements, it will not be a primary driving factor behind the recommendations established from this analysis and is recommended as an area for future study. It will be assumed that for each CQRM there is a possible crew workflow that supports the responsibility assignment of each crewmember.

The next assumption was that multipurpose crew vehicle (MPCV) pilots were not required to remain on the Mars mission. It was assumed that a ferry to orbit approach could be used where multiple launches would bring the crew to the MTH, so MPCV pilots were not needed within the crew. Separate pilots could be used to bring all crew members into space and bypass the need for MPCV pilots within the crew. If crew training allowed, MPCV pilots would still be included, but they were not a priority in the assignment of crew responsibilities, to examine minimal crew sizes.

Additionally, it was assumed that all responsibility related to the Mars surface expedition would be filled and the MTH crew would act as support to the surface crew. This means that responsibilities associated with piloting and docking the MAV and MDV would be covered by the surface crew. The MTH crew would provide support for activities like EVAs and other operations but would not have to directly participate in many surface habitat activities.

It was also assumed that there were no limitations on the number of specialist positions that a crewmember could take. Any crewmember would be eligible for all specialist positions and could have any number of them. SMEs have not given a recommendation on specialist positions or their limitations so it was assumed that any pairings would be allowable.

All training hours for the purpose of balancing the CQRM were derived from the NESC report [3]. These hours were assumed based on hours for heritage programs, such as ISS and the SpaceX Dragon. Lead training hours were established from flight controller training hours for the respective positions and through discussions with SMEs. Training hours are outlined in **Table 1**.

The final assumption was that a crewmember could not be a lead in more than one core system grouping paired with an EVA responsibility. This assumption was derived from NESC's recommendations based on their discussion with SMEs [2].

## 5. Results

*Eight Person Crew*

The first piece of analysis looks at the most expansive crew sizing necessary for the Mars vicinity. This used the least aggressive approach for crew responsibility groupings by using the assumption of that one core system lead could be paired with an EVA lead. With this restriction and a desire to have redundancy in leads for all core systems, a crew size of eight for the Mars vicinity was found as the upper bound. The primary lead pairings for the eight-person crew were:

- TCS
- CDH with LAN + C&T + EPS
- MCS + Prop
- ECLSS

Two crewmembers were assigned to each of these groupings. The remaining leads for crew medical officer and the specialist positions were then distributed among the crew to bring them to an equalized distribution of hours. Additionally, Emergency Operations leads were assigned to the TCS leads. The full crewmember assignments with the final associated hours are shown in **Table 2**.

A useful feature of this crew size is the ability to have a rotating EVA support crew. This supports the Mars Surface crew's ability to perform daily EVAs by having multiple support crews available in the MTH so fatigue can be effectively managed. It also allows for concurrent EVAs in the worst-case scenario where a contingency EVA is needed on the MTH while the surface crew is on an EVA by having enough crew members trained to have two EVA support teams with two EVA hardware & task crewmembers.

Another important feature of the eight-person crew is that it supports the additions of MPCV pilots & commanders. There is enough flexibility within the training hours of the Mars vicinity crew to be able to add MPCV pilots with mild to no restructuring of crew responsibility. This analysis did not further explore this option because of the assumption that the ferry to orbit approach would be used, however if pilots are desired, these could be added to the crew's responsibilities within a two-year training flow.

*Six Person Crew*

Next, a more aggressive approach was taken to minimize the crew size while keeping redundant leads in each core system grouping recommended by the SMEs. Weighing these constraints while prioritizing a redundant lead in all responsibilities results in six crew members. This created three general core system groupings:

- CDH with LAN + C&T + EPS
- ECLSS + TCS
- MCS + Prop

These groupings are derived most directly from the recommendations by the NESC and with two crewmembers assigned to each grouping, it allows for redundancy in all core systems. Each crewmember was trained to lead capability in EVA responsibilities and the remaining lead and specialist positions were distributed among the crew. The full crewmember assignments are shown in **Table 3**.

The obvious advantage of a six-person (and larger) crew size is the core system lead redundancy. It additionally supports daily EVAs for the surface crew by having enough crewmembers to have a fresh daily EVA team at any point. There are also enough crewmembers to run contingency EVAs when necessary on the MTH and still have the ability to have a lead for any core system available should something go wrong. This is the minimum crew size that allows full redundancy in core systems with the current constraints dictated by SMEs. Finally, there is enough space in the training hours that it could be possible to support MPCV pilots in the six-person crew. This would require a more aggressive restructuring of the CQRM and the changing of some groupings, but with the excess hours between all crewmembers adding MPCV pilots is possible.

*Five Person Crew*

The next crew sizing that was studied looks at the tradeoff of losing redundancy in core systems while maintaining crew to perform contingency EVAs in the MTH. With two EVA task members needed and three crew members providing IVA support of the EVA, this drives a crew sizing of five. With five crew members it is not possible to have a redundant lead in each core system, so the MCS and Prop lead were not prioritized as it was thought that this would be the least likely systems to have a failure while an EVA is being conducted. This results in core system groupings that are identical to the six-person crew, but with two crew members each assigned to the ECLSS + TCS and CDH with LAN + C&T + EPS and one crew member on the MCS + Prop pairing. The full crew assignments are shown in **Table 4**.

While this crew size does accept more risk with the lack of lead redundancy, it does have some advantages. There is still enough training budget to train all crew members to be EVA leads to support some cycling of EVA support responsibility when daily EVAs are necessary on the surface to prevent overload. With the desire to have EVA capability for the on-orbit crew, this is the smallest crew size possible. With more stringent constraints and more accepted risk however, a smaller crew could be possible.

*Three Person Crew*

Finally, the most aggressive approach was analyzed for the vicinity crew. By focusing on only one lead per core system grouping and having the bare minimum required for an EVA support crew, a vicinity crew of three members was possible. The three lead groupings for this crew are:

- Emergency Operations + CDH with LAN + C&T + EPS + Medical + EVA
- Emergency Operations + TCS + ECLSS + EVA
- MCS + Prop + Medical + EVA

Specialist positions were assigned for redundancy in core systems and for the various other tasks, which are outlined in **Table 5**.

However, a crew of this size comes with greatly increased risk. A crew of this size would not have the ability to perform contingency EVAs on the MTH while the surface crew is on the Mars surface because there are not enough crewmembers to supply EVA support and follow the standardized EVA buddy system for the actual task. Additionally, with no redundant leads should a crewmember be incapacitated, there is no one able to take their place and perform their duties without significant retraining. The capacity for onboard training is an area of further research and it is unclear whether a crewmember would be able to reach proficiency. Overall, this crew size comes with greatly increased risk due to the overall responsibility increase of each crewmember and the lack of redundancy in key systems. The three-person crew serves as a minimum to the trade space for on-orbit crew size with the current constraints as it is not possible to have less crewmembers with the given assumptions.

## 6. Conclusions on Crew Sizing

The primary takeaway from the analysis of crew expertise necessary for the on-orbit crew is that the training hours necessary for the required responsibilities is not the limiting factor. The primary constraints on the on-orbit crew are the number of required responsibilities and the responsibility pairings allowable by SMEs. Since the SMEs have determined a maximum responsibility capacity that a singular crewmember can be trained to as a lead, each crewmember is limited by this and its effect on their daily schedule in orbit and not the training hours necessary on the ground for these positions.

Because of these findings and with a priority on redundancy and reducing risk to all crewmembers, an on-orbit crew of five to eight crewmembers could be trained to encompass all required qualifications within a two-year training flow. Three crewmembers would encompass the bare minimum of qualifications with a greatly increased risk to all crewmembers due to lack of redundancy in core system responsibilities and the lack of support for contingency EVAs in the MTH. A crew size of five to eight balances the need for redundancy and contingency plans within the Mars vicinity. Additionally, as the crew sizes trend to the upper end of this range, the ability manifests to add in additional expertise to assist in the mission, such as MPCV pilots or other unforeseen responsibilities.

When combined with the results from the Mars Architecture team and their study on surface crew sizing, this drives a crew complement to the Mars vicinity of 6 to 14 crewmembers.

## 7. Future Work

The recommended crew complement to the Mars vicinity creates a new problem that must be understood before any expeditions can be conducted. Even when looking at the minimum size of 8, this is a larger crew size than has ever been conducted before and is not contained by the current recommended architectures for transport to Mars. A vehicle or concept does not currently exist in a functional state that could support crews of this size which brings a new gap that must be addressed: What is the current gap between existing technology and what is necessary to support the expedition to Mars?

When viewed from a lens of human system integration, the largest gaps appear in the overall sizing necessary for the MTH and all logistics necessary to support a Mars expedition. Additional complications are introduced into this problem with the consideration that there are three different mission lengths commonly referenced: 550, 860, and 1100 days. Each of these drives a different overall sizing for which more work must be completed to fully understand.

The CQRMs developed in this analysis should be examined by SMEs to ensure that all allocations are considered reasonable. Although these CQRMs were developed using rules captured in previous NESC studies, it is possible that additional constraints could be imposed by operations SMEs given new crew member assignments that have not previously been examined.

Additionally, there is a gap in how daily workload affects the crew size needed. To fully understand the crew sizes needed, additional work must be completed looking at workload and scheduling. How many crewmembers will be needed to ensure all systems are operational around the clock? More research must be completed to ensure there is an understanding of how these crew responsibilities affect workload and overall operation.

This study marks a beginning to defining the tradespace of the Mars on-orbit crew and assists in driving the decision of the crewmembers needed in the Mars vicinity. By focusing on the expertise necessary to operate in the MTH, a bound emerges on the crew necessary to safely complete this endeavor. With future research into how the workload of these responsibilities affects the crew complement and study of the resultant habitat sizing of these larger crew sizes, a design for the Mars mission can begin to take shape.

## 8. References

[1] Chaikin, A., “Humans to Mars, But How Many? A Historical Review of Crew Size Determinations for Mars Missions,” NASA CR−20240015749, December 2024.

[2] Dempsey, D. et al, “Trade Space Analyses: Balancing Crew and Mission Design Parameters,” NASA TM−20240011265, August 2024.

[3] Sapp, J. et al, “Model Crew Complement to the Surface of

Mars," NASA "NESC-25-02085 (not yet published).

## Appendix A: Acronyms & Nomenclature List

| | |
|---|---|
| C&T | Communication & Tracking |
| CDH w/ LAN | Command & Data Handling System with Local Access Network |
| CQRM | Crew Qualifications and Responsibilities Matrix |
| ECLSS | Environmental Control and Life Support System |
| EVA | Extravehicular Activity |
| ISS | International Space Station |
| MAV | Mars Ascent Vehicle |
| MCC | Mission Control Center |
| MCS | Motion Control System |
| MDV | Mars Descent Vehicle |
| MPCV | Multipurpose Crew Vehicle |
| MTH | Mars Transit Habitat |
| NASA | National Aeronautics and Space Administration |
| NESC | NASA Engineering and Safety Center |
| PETRM | Personal Expertise and Training Model |
| Prop | Propulsion |
| SME | Subject Matter Expert |
| TCS | Thermal Control System |

## Appendix B: Reference Tables

| Position | Lead Hours | Specialist Hours | Operator Hours |
|---|---|---|---|
| MPCV Crewmember | - | - | 406.72 |
| **Mars Transit Habitat Responsibilities** | | | |
| Emergency Operations | 210.00 | - | 105.25 |
| Activation/ Deactivation | - | - | 10.00 |
| Logistics | - | 13.00 | - |
| CDH w/ LAN | 244.50 | 20.00 | 11.25 |
| C&T | 108.00 | 9.00 | 6.25 |
| EPS | 218.46 | 7.50 | 3.50 |
| MCS | 563.00 | 9.50 | 3.50 |
| Prop | 100.00 | 18.00 | 3.50 |
| TCS | 294.23 | 9.50 | 1.00 |
| ECLSS | 370.00 | | |
| Intravehicular Maintenance | 441.00 | 34.00 | - |
| Habitability | - | 33.50 | - |
| Photo/TV | - | 22.50 | - |
| EVA Support | 334.75 | - | - |
| EVA Task | 128.00 | - | - |
| EVA Hardware | 110.25 | - | - |
| Crew Medical Officer | 78.00 | - | 48.00 |
| Medical Operations | - | - | 143.00 |
| Robotic Operations | - | 74.00 | - |
| Track & Capture | - | 19.00 | - |
| Payload Science | - | 39.6875 | - |

**Table 1: Training Hours by Position Expertise from NESC Report [3]**

| Position | Crew A | Crew B | Crew C | Crew D | Crew E | Crew F | Crew G | Crew H |
|---|---|---|---|---|---|---|---|---|
| MPCV Crew | O | O | O | O | O | O | O | O |
| Emergency Operations | L | L | O | O | O | O | O | O |
| Activation/ Deactivation | S | S | S | S | S | S | S | S |
| Logistics | S | S | S | S | S | S | S | S |
| CDH w/ LAN | O | O | O | O | O | L | O | L |
| C&T | O | O | O | O | O | L | O | L |
| EPS | O | O | O | O | O | L | O | L |
| MCS | O | O | O | O | L | O | L | O |
| Prop | O | O | O | O | L | O | L | O |
| TCS | L | L | O | O | O | O | O | O |
| ECLSS | O | O | L | L | O | O | O | O |
| Maintenance | S | S | S | S | S | S | S | S |
| Habitability | S | S | S | S | S | S | S | S |
| Photo/TV | S | S | S | S | S | S | S | S |
| EVA Support | L | L | L | L | L | L | L | L |
| EVA Task | L | L | L | L | L | L | L | L |
| EVA Hardware | L | L | L | L | L | L | L | L |
| Crew Medical | O | L | O | O | O | L | O | O |
| Medical Operations | O | O | O | O | O | O | O | O |
| Robotic Operations | - | - | S | S | - | - | - | - |
| Track & Capture | - | - | S | S | - | - | - | - |
| Payload 1 | S | - | - | - | - | - | - | - |
| Payload 2 | - | S | - | - | - | - | - | - |
| Payload 3 | - | - | S | - | - | - | - | - |
| Payload 4 | - | - | - | S | - | - | - | - |
| Total Hours | 1852.89 | 1868.89 | 1886.66 | 1886.66 | 2057.22 | 1981.18 | 2071.22 | 1951.18 |

**Table 2: CQRM for 8 Person Crew**

| Position | Crew A | Crew B | Crew C | Crew D | Crew E | Crew F |
|---|---|---|---|---|---|---|
| MPCV Crew | O | O | O | O | O | O |
| Emergency Operations | L | O | O | L | O | O |
| Activation/ Deactivation | S | S | S | S | S | S |
| Logistics | S | S | S | S | S | S |
| CDH w/ LAN | L | O | O | O | O | L |
| C&T | L | O | O | O | O | L |
| EPS | L | O | O | O | O | L |
| MCS | O | O | L | O | L | O |
| Prop | O | O | L | O | L | O |
| TCS | O | L | O | L | O | O |
| ECLSS | O | L | O | L | O | O |
| Maintenance | S | S | S | S | S | S |
| Habitability | S | S | S | S | S | S |
| Photo/TV | S | S | S | S | S | S |
| EVA Support | L | L | L | L | L | L |
| EVA Task | L | L | L | L | L | L |
| EVA Hardware | L | L | L | L | L | L |
| Crew Medical | O | O | O | O | L | L |
| Medical Operations | O | O | O | O | O | O |
| Robotic Operations | - | - | S | S | - | - |
| Track & Capture | - | - | S | S | - | - |
| Payload 1 | - | - | - | - | - | S |
| Payload 2 | - | S | - | - | - | - |
| Payload 3 | - | - | S | - | - | - |
| Payload 4 | - | - | - | S | - | - |
| Total Hours | 2069.93 | 2086.89 | 2189.91 | 2284.64 | 2087.22 | 2020.87 |

**Table 3: CQRM for 6 Person Crew**

| Position | Crew A | Crew B | Crew C | Crew D | Crew E |
|---|---|---|---|---|---|
| MPCV Crew | O | O | O | O | O |
| Emergency Operations | O | O | O | L | L |
| Activation/ Deactivation | S | S | S | S | S |
| Logistics | S | S | S | S | S |
| CDH w/ LAN | L | S | O | L | O |
| C&T | L | S | O | L | O |
| EPS | L | S | O | L | O |
| MCS | S | O | L | O | O |
| Prop | S | O | L | O | O |
| TCS | O | L | O | S | L |
| ECLSS | O | L | O | S | L |
| Maintenance | S | S | S | S | S |
| Habitability | S | S | S | S | S |
| Photo/TV | S | S | S | S | S |
| EVA Support | L | L | L | L | L |
| EVA Task | L | L | L | L | L |
| EVA Hardware | L | L | L | L | L |
| Crew Medical | O | O | O | L | L |
| Medical Operations | O | O | O | O | O |
| Robotic Operations | S | - | - | S | - |
| Track & Capture | S | - | - | S | - |
| Payload 1 | - | - | - | - | S |
| Payload 2 | - | S | - | - | - |
| Payload 3 | - | - | S | - | - |
| Payload 4 | - | - | - | S | - |
| Total Hours | 2064.68 | 2102.39 | 2096.91 | 2233.87 | 2235.64 |

**Table 4: CQRM for 5 Person Crew**

| Position | Crew A | Crew B | Crew C |
|---|---|---|---|
| MPCV Crew | O | O | O |
| Emergency Operations | L | L | O |
| Activation/ Deactivation | S | S | S |
| Logistics | S | S | S |
| CDH w/ LAN | L | S | O |
| C&T | L | S | O |
| EPS | L | S | O |
| MCS | S | O | L |
| Prop | S | O | L |
| TCS | O | L | S |
| ECLSS | O | L | S |
| Maintenance | S | S | S |
| Habitability | S | S | S |
| Photo/TV | S | S | S |
| EVA Support | L | L | L |
| EVA Task | L | L | L |
| EVA Hardware | L | L | L |
| Crew Medical | L | O | L |
| Medical Operations | O | O | O |
| Robotic Operations | S | - | S |
| Track & Capture | S | - | S |
| Payload 1 | S | - | - |
| Payload 2 | - | S | - |
| Payload 3 | - | - | S |
| Payload 4 | - | S | - |
| Total Hours | 2253.12 | 2246.83 | 2235.16 |

**Table 5: CQRM for 3 Person Crew**