

**National Aeronautics and Space Administration  
Washington, DC**

**NASA ADVISORY COUNCIL  
Human Exploration and Operations Committee  
August 29, 2024**

**MEETING MINUTES**

**Bette Siegel**

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**Bette Siegel, Executive Secretary**

**Lynn F. H. Cline**

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**Lynn Cline, Chair**

**Public Meeting Minutes  
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*Meeting Report prepared by  
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August 29, 2024

### Opening Remarks

Dr. Bette Siegel, Executive Secretary of the Human Exploration and Operations Committee (HEOC), called the meeting to order, provided details of Federal Advisory Committee Act rules, and made administrative announcements. She introduced the Interim Chair of HEOC, Ms. Lynn Cline. Ms. Cline welcomed everyone to the meeting and noted that, although the committee spans two organizations within NASA, this meeting would focus on the Exploration Systems Development Mission Directorate (ESDMD); there will be a meeting on 17 September that will focus on the Space Operations Mission Directorate (SOMD).

Ms. Cline announced that Dr. Siegel would be stepping down from the role of Executive Secretary after the meeting on 17 September. She thanked Dr. Siegel on behalf of the committee for all her efforts and acknowledged the contributions she has made to the committee. Dr. Siegel then introduced Ms. Erin Stuart as the next Executive Secretary for HEOC.

### Exploration Systems Development Mission Status

Ms. Catherine Koerner, Associate Administrator (AA) for ESDMD, provided the update on the Artemis campaign. She noted that May 5 marked the one-year anniversary of ESDMD and the establishment of the Moon to Mars (M2M) Office and Strategy and Architecture Office (SAO). She said a rhythm has been established, allowing for the clear definition and management of the suite of programs and projects necessary to execute Artemis. An evolvable architecture has been crafted for human exploration beyond low Earth orbit to achieve exploration goals.

### *Artemis II*

Artemis II is scheduled to launch in September 2025 and will carry four astronauts, including the first woman, first person of color, and first international partner to venture around the Moon and back to Earth. The 10-day space flight will include physical and biological science experiments to collect critical data on human health. Safety is top priority and Artemis II will not fly until it is safe to do so. Preparations for Artemis II and future Artemis missions are being informed by lessons learned from the Artemis I flight. The core stage for Artemis II is being prepped for the integration of other launch system elements, including the Orion spacecraft components, at the Kennedy Space Center (KSC), and infrastructure upgrades have been made based on comprehensive assessments of the Mobile Launcher (ML) post-Artemis I and Launch Pad 39B. Trainings have included a full-day crew training exercise inside a mock-up of the Orion capsule and a comprehensive field geology training exercise in Iceland. Stand-ins for the flight crew practiced emergency egress procedures at KSC. The Launch Vehicle Stage Adapter (LVSA) is en route to KSC with components for Artemis III and Artemis IV, as well. The selection of Andre Douglas as backup astronaut for Artemis II was announced; he joins Jenny Gibbons, who was named as the Canadian Space Agency backup.

### *Artemis III*

Artemis III is planned for 2026 and will make history by sending the first humans, including the first woman, to explore the region near the lunar South Pole. The SpaceX Starship Human Landing System (HLS) will transport two astronauts between the Orion spacecraft in lunar orbit and the Moon and then back to Earth. SpaceX will fly at least one un-crewed demo mission.

Axiom Space is providing the Artemis III surface suits and spacewalk systems. Astronaut training and field testing of potential Artemis technology is being done. Starship has conducted its fourth flight test, which included its first ever landing burn, and the fifth flight test is scheduled for fall 2024. The Interim Cryogenic Propulsion Stage (ICPS) has completed final testing and checkout, one of the last steps before this stage is turned over. Astronauts wearing pressurized spacesuits have interacted with the mock-up of Starship hardware, including the HLS airlock. The processing of four RS-25 engines is complete and the liquid oxygen tank for Artemis III core stage has completed welding. The European Service Module (ESM-3) is expected at KSC in early September.

### *Gateway*

Gateway will be NASA's cislunar orbiting space station that will help enable future missions beyond Artemis III. Maxar has installed the tanks for the xenon propellant into the Power and Propulsion Element (PPE). Teams at Thales Alenia Space in Italy have begun safety and integrity stress tests for the Habitation and Logistics Outpost (HALO) element. Once tests are complete, the modules will be transferred to Arizona for final outfitting by Northrop Grumman. In June, the Canadian Space Agency (CSA) started work on the Canadarm3 robotic arm. Virtual reality simulations of navigating and performing tasks inside Gateway have been used to help refine elements of its interior design. The Gateway airlock will be provided by United Arab Emirates (UAE), and Ms. Koerner noted that, in 2020, the U.S. and UAE were among the original signatories of the Artemis Accords.

### *Artemis IV*

During Artemis IV, Gateway will be joined in polar orbit around the Moon by a second habitation element: the International Habitation module (I-Hab). Lunar I-Hab is provided by the European Space Agency (ESA), with significant hardware contributions from the Japanese Aerospace Agency (JAXA). I-Hab will provide habitable volume for the four astronauts to conduct science. While two crew members stay at Gateway, another pair of astronauts will enter the Starship HLS to disembark to the lunar surface to execute the Artemis IV science activities.

Teams recently completed two important construction milestones for the ML2: on 9 May, the 'Jack and Set' connected the launcher base to its permanent mount, and construction of the ML2 tower sections is now underway. Crews have installed the first of three commodity chases, designed to support the fluids and gasses for each level of the ML2 tower. Testing of the Exploration Upper Stage Umbilical (EUSU) is complete. The liquid hydrogen tank for Artemis IV core stage is currently being manufactured. All four universal stage adapters structural test article panels have been aligned and loaded onto the Vertical Assembly Tool (VAT).

### *Artemis V*

Artemis V will be the fourth crewed test flight under the Artemis campaign and will demonstrate the capabilities of a second HLS provided by Blue Origin: The mission will have a lunar terrain vehicle (LTV) as well. Three companies were selected by NASA to refine their concepts for the LTV, which will be an unpressurized and unenclosed rover to enable astronauts to explore wider areas on the lunar South Pole. The ESA-provided European System Providing Refueling, Infrastructure and Telecommunications (ESPRIT) Refueling Module will be added to Gateway as part of Artemis V.

In April, representatives from the U.S. and Japan signed an agreement for a pressurized rover that will accommodate two astronauts on the lunar surface for about 30 days. With a lifespan of about 10 years, it can be used for multiple missions and will be able to be operated remotely to conduct science both between crewed flights and for 365 days/year from the time it lands. NASA has contracted SpaceX and Blue Origin to develop cargo versions of their HLS landers. Blue Origin continues to make exceptional progress designing and building components to support the Artemis campaign. ESDMD is looking forward to the inaugural launch of the New Glenn rocket. There is currently hardware in production through Artemis IX.

#### *International Collaborations | Global Partners*

The Artemis campaign's international partnerships are core to Artemis and provide critical capabilities in lunar orbit and on the lunar surface. A prime example is NASA's annual M2M architecture workshops, which engage space agencies from around the world. In 2024, 18 countries were represented. The next international workshop is scheduled for February 2025.

#### *Artemis Accords*

Enduring relationships are being built globally. In 2020, the U.S. and seven other nations were the first to sign the Artemis Accords, which established a set of principles for promoting the beneficial use of space for humanity. There are now 43 countries committed to the safe, transparent, and responsible exploration of the Moon and beyond.

Ms. Koerner finished her comments by noting that Artemis and the campaign is beyond anything humanity has ever achieved. She said it is the most interconnected, international, interdisciplinary campaign ever conceived and represents the birth of a lunar ecosystem with increasing capabilities for exploration and science. She said the team appreciates the support from HEOC, the public, and its stakeholders, who recognize the importance of Artemis, not just for NASA and the U.S. but for space-faring nations internationally.

Mr. Kwatsi Aliburharo asked about what had to be spruced up from Artemis I. It was noted that Mr. Amit Kshatriya would address that during his talk.

Dr. George Sowers noted that, if the schedule is kept for Artemis II next year, it will have been 3 years since the launch of Artemis I and asked what is being done to maintain the KSC launch crew proficiencies. Ms. Koerner said that training activities for Artemis II include involvement in ground activities and preparation of launch system hardware. The launch crews are participating in simulated activities, are helping with development and upgrades to the ML system, and are also involved in the development and aggregation of hardware for Artemis II. So they get both hands on experience with the systems they are launching and get to do the training activities in preparation for the mission.

Mr. Jim Voss asked about the development of the launch control team. He noted that the Starship HLS is in early development but there has not been much information about crew compartment, controls, displays, etc. He asked whether that was in process or if it might be a late thing that could make it difficult for the crews to be ready for launch. Ms. Koerner said crews are heavily involved with designers at SpaceX, and they spend regular time there; also, there may be resident

crew members in the facility, working on the interface for the HLS. Mr. Voss asked whether it is on track for training for HLS interfaces. Ms. Koerner said the crew is involved in the development of the HLS interfaces and the training activities. Mr. Voss then asked about budget: since NASA got less than expected, is funding on track or is the budget cut affecting this program. Ms. Koerner said everything in developing programs takes more resources than initially forecast; she added that, given post-COVID era and from a supply chain perspective and supplies in general, the program would benefit from additional resources and has challenges from the reduction in budget. Still, as a whole, they have had what they need to continue to make progress.

Dr. Condon said he was surprised not to see Russia or China represented on the Artemis Accords signatories list. He asked if there is any effort ongoing to try to include them in these accords. Ms. Koerner said that the Artemis Accords are open to any countries who agree to the principles represented in the accords. She cannot speak for countries that have not chosen to sign on; but there is regular dialog and multiple open channels about the principles and opportunity to sign.

### Strategy and Architecture

Ms. Nujoud Merancy, Deputy AA for the SAO within ESDMD, gave a number of updates. She said the annual Architecture Concept Review (ACR) is mid-process in getting to the November ACR meeting and publication of updates in the Architecture Definition Document (ADD).

Ms. Merancy reviewed the highlights of the Strategic Analysis Cycle (SAC). It was the first time for cross-directorate-led tasks; 22 priority tasks were reviewed, and two mid-cycle white papers were published. She reviewed the 2024 ACR themes and noted that work continues to find the best ways for stakeholders to engage and to hear about outcomes. There are two new elements through Mission Concept Review (MCR) that will be reviewed at ACR24 for adoption into the architecture.

Ms. Merancy next talked about architecture decisions and technology gaps. Last year an Architecture Decision Roadmapping Process was created to determine the big decisions that need to be made today to establish the architecture of the future. Five new decisions will be proposed at ACR24. The office has derived the technology gaps the architecture needs and those gaps will be reviewed and published in the ADD in the coming year.

NASA has migrated the decomposition that appears in the ADD into a Model-based systems engineering (MBSE) environment for a single source of truth. The tool allows for connection to the Architecture Decision Roadmapping Process, which is also in MBSE and, notably, has won the ESDMD innovation award. Ms. Merancy said that fulfilling the architecture in a digital environment enables tools that will strengthen analysis in the future.

Two mid-cycle white papers were published: one about the lunar surface cargo demand and one about mobility demand based on that cargo and the process for moving it. These papers were published early to initiate the collaboration with industry and grow awareness among stakeholders.

For the Lunar Surface Cargo Background, there are a number of delivery services today, including HLS, Human-class Delivery Lander, and Commercial Lunar Payload Services, which are large scale. There is also a small cargo lander MCR in 2024. There are 17 functions in the ADD Rev-A, which is currently published: nine are key; eight are identified as potential.

Ms. Merancy stressed that, when taken in the aggregate, the amount of demand is very challenging. With the four crew for 30 days on the surface benchmark, in the out years the demand is between 4,000 kg and 6,000 kg of cargo per year. With other systems, such as infrastructure and science systems, it is somewhere between 2,500 kg to 10,000 kg per year of logistics and cargo, in excess of delivering large elements like the pressurized rover. She noted that the challenge of architecting this for the future is clearly a large amount of cargo that will be needed on an annual basis. There is a gap between the current maturity of systems and what is pre-formulation and concept. Being able to work with industry to understand the demand is critical. Other challenges include ensuring infrastructure, science, and cargo can be deployed where it is needed at the lunar South Pole. Multiple providers in the architecture will be necessary to ensure a mixed fleet of cargo lander approaches and capabilities.

For lunar mobility, the architecture includes several mobility functions. There are 34 functions already allocated in the ADD and a significant demand for cargo. NASA has two projects in the works: the LTV and a JAXA Pressurized Rover (PR), with a primary purpose of moving humans around on the surface. The PR will carry cargo for human use but does not have capability to use large scale cargo for un-crewed or other purposes; the LTV does have some performance capability. Currently these cargo and mobility assets are only able to hold up to about 1600kg.

Ms. Merancy reviewed the historical context for lunar mobility, which includes six missions to the Moon. On all of those missions, less than 10 km per mission of actual range was produced. Regarding lunar mobility demand, multiple tons of material per mission needs to be relocated or power systems need to be deployed in ideal locations. The experience base versus projected capability represents a significant gap. Ms. Merancy said that these challenges present an opportunity for significant technological collaboration with industry and all stakeholders. The lunar South Pole is a challenging and different environment, with many factors that drive a need to relocate, from terrain effects to shadowing effects. You might have to move at least 50 m from the lander to get out of shadow to deploy solar arrays effectively, or there may be a need to move away from lander ejecta. Aggregating across the surface, the range is a mobility not just in terms of tons to land but how far things must be moved (distance). Ms. Merancy said, regarding the lunar mobility technology, payload mass to the mass of the vehicle and effective movement of systems is a huge technological challenge that must be overcome in order to close on the architecture needs to support surface exploration.

Ultimately, for lunar mobility, three challenges need to be addressed: the tonnage of cargo, the multiple technologies of distance, and the technology scaling for being able to move the larger systems which are not just scaling up from small ones. A solicitation for study proposals from industry has been issued and future collaborations will be a key piece of closing the foundational exploration surface architecture.

Mr. Alibaruho said the tool to help identify the architecture gaps looks like an improvement and asked how adoption was achieved so people and processes flow with the new tool for maximum benefit. Ms. Merancy responded that, especially when using Excel and leading into the MBSE transition, the knowledge of a gap is clear if a function is not assigned. Important visuals are possible, e.g., things mapped to one element and not another, that may help with analysis. She said the first challenge was getting data in the system, then linking technology gaps to decisions and to the functions and needs in architecture. This will help reveal technology gaps in one area or preceding technology work that needs to inform a decision.

Dr. Sowers asked whether assessment for cargo was for down mass only, or if there are also looks at up mass demand? Ms. Merancy said yes, up mass demand been listed as a gap in the architecture since the first ADD release. Regarding large cargo return, Orion has a limited return capability. Large cargo demand is being aggregated and looked at to be able to return a greater number of samples of more types, potential freezers and cryogenic samples, as well as hardware spares or other types of equipment for investigation on earth or reuse. The most efficient way is to carry up mass from HLS to the surface to Gateway and then fly return systems from Gateway; this recommendation has already been made and trades are being considered to accomplish this.

Mr. Voss asked whether studies on habitat needs and capabilities have begun. Ms. Merancy said they have, that it has been a huge volume of work over the years. One of the systems going to ACR in November is the initial surface habitat: a smaller scale habitat that will be the footprint for extending the mission or expanding the crew size on the surface. Part of the recurring SAC is that aggregation or growth of habitation capability. Mr. Voss asked for information about the point in the process that Requests for Proposal (RFPs) are issued for studies or information from industry and how far they are from that for habitats, noting a concern of getting behind. Ms. Merancy said there is currently a next step APP-A on habitation studies which has been around for almost a decade. Also, part of the cycle every year is prioritizing the trades, what is needed most and soonest; and assessing budget projections, how soon they can ramp up into habitation. Mr. Voss sought clarification that nothing specific for the Artemis program is issued right now and asked whether we are at the point for knowing what will be possible to do within the Artemis framework. Ms. Merancy answered that the international partners also bring capabilities, so between U.S. industry studies and international partners there are a number of activities and work to address Artemis needs, specifically.

Dr. Condon asked about the thinking or planning with regard to human waste collection, storage, processing, and disposal. Ms. Merancy said that logistics include the discussion of the delivery and management of the waste. In the RFP that was just done, one of the contract line items is for trash management. Dr. Condon asked whether the thinking is for onsite disposal or will it be part of mass considerations. Ms. Merancy said, generally, they are considering onsite disposal or storage of it, as there are a number of mass constraints. The up mass probably would not support taking everything away and that would introduce a number of challenges.

Ms. Budden, thinking about the peculiarities of having a South Pole site, and noting that NASA has been pushing that for years and people are thrilled, asked whether there are other considerations and studies, workshops, etc. beyond just the shadowing, such as special communications issues because of the location satellite support, etc. Are there other activities



examining what needs to be done in advance to support a South Pole mission? Ms. Merancy said a number of factors are being considered: the lighting (not just the shadow for cold considerations but the power generation that is available); the communications direct to Earth; the Moon's slight wobble causing the Earth to come in and out of view; and the terrain features. So, communications has already driven collaborations with Space Communications and Navigation partners to provide relay satellites to close the communication gap to the South Pole as well as the relay capability Gateway provides. Communications is a big piece and so are the terrain features, being able to land in regions that are peaks and ridges, get the lighting and communication, be free of hazards, all of those factors are under consideration. Ms. Budden asked whether part of it is recovering some of the frozen carbon dioxide water ice for use by the crew. Ms. Merancy said yes, for science reasons and the potential for In-situ resource utilization (ISRU) access to permanently shadowed regions is considered in the site analysis. Some of these processes are happening in partnership with STMD. Ms. Budden said this introduces some new safety rules that may not have been considered before. Ms. Merancy agreed and said that safety and interactions with crew are all being discussed and included in the requirement in the systems as they are developed.

Dr. Sowers said that, regarding ISRU, a lot of people in the field were disappointed to hear that Volatiles Investigating Polar Exploration Rover (VIPER) was canceled. He asked whether ESDMD had a say in that decision? Ms. Koerner said ESDMD was asked what its requirements were; ESDMD did not exist when VIPER was instantiated, and it is a Science Mission Directorate (SMD) mission, so the requirements and activities were purely for science. The activities VIPER was conducting on its mission that could contribute to the architecture overall were looked at, and there were limited opportunities for it to be able to fulfill the ESDMD exploration objectives. Dr. Sowers said that is hard to understand given that if VIPER were able to find strong indications of water ice in some of those shallower PSRs that would have huge implications for long-term sustainability.

Dr. Condon noted that during the Apollo days there was great concern and mitigating processes put in place to protect against microorganisms from the Moon being returned to Earth and causing issues with all forms of life. He asked, given potential long-term stays, what kind of protections are being provided to ensure something of a biological nature is not left behind on the Moon that may negatively impact future explorers. Ms. Merancy said that during the time of Apollo, planetary protection was much higher because the lunar environment was not understood as well. All of the work being done is in adherence to the current lunar planetary protection requirements and policies and trash management concerns for microbial growth are being addressed as systems are developed.

Mr. Ebersole expressed concern about the possibility that international partners could come forward with opportunities and value propositions and the 100s of potential scenes from the flag chart and asked what processes are being put in place to avoid conflict. Ms. Koerner said the flag chart represents countries that have expressed a desire to explore using common values. Within the construct of those, a number have also approached individually to say they want to be part of Artemis, specifically, so there is work with other countries and their space agencies to establish agreements for participation in Artemis as a campaign and through the missions. Mr. Ebersole sought to clarify: from a perspective of value creation, one flag wants to do one thing, one wants

to do another or partner in a certain domain and it seems to be controlled, did Ms. Koerner see any concerns there by the framework of their participation? Ms. Koerner said she does not have those concerns, partly because there are a number of venues where representatives from those countries can interact – not only with Artemis Accord signatories, but also with other space faring nations. There are discussions about what each nation is doing to ensure all can live by existing international treaties for deconflicting space activities; for instance, the International Space Exploration Coordination Group includes a number of countries that are not Artemis Accord signatories and there is regular talk about common activities and values, outside of even the Artemis Accords, for exploration.

## Moon to Mars

### *Artemis II Progress*

Mr. Amit Kshatriya, Deputy AA of the M2M Office, began by reviewing the spacecraft processing, the principal item in terms of readiness. He said Artemis II is reliant on infrastructure that has been handed down, so a lot of refurbishment and maintenance has been necessary to get the vehicles moving. The Crew and Service Module has completed Electromagnetic Interference/Electromagnetic Compatibility testing and the first series of vacuum tests and functionals are done. Propulsion system testing is up next. The Environmental Test Article will be tested to complete human rating, and other abort qualification tests post-mission will begin in the next month at Armstrong. Items affecting readiness include the resolution of a motor control issue on the life support system; a valve controller anomaly for which a fix has been determined; and an observed issue with the Crew Module (CM) batteries, which have been redesigned and requalified – now, flight articles must be finished and shipped for installation.

On the Pad side of Artemis II, there is a lot of work on crew training. There has been extensive refurbishment of the ML1 post-flight considering the interaction of the ML with the plume environment during launch. New developments at KSC are necessary, including the incorporation into the cryogenic topology of a new cryogenic sphere. The crew loading timeline for Artemis II is much more aggressive. Integration of a new cryogenic storage tank, pressure feed lines at Pad B, and a crew egress system and access arm, among other capabilities, had to be incorporated into the facility. Subterranean facilities had to be addressed to ensure, for instance, that pipes are up to code. Mr. Kshatriya spoke about the readiness of the launch support team and the demands placed on them. When there is integrated hardware and testing, the launch control team is in the loop and there will also be an additional role for an assimilated launch countdown to ensure maximum efficiency for that team.

For the Artemis II launch vehicle, core stage is in the Vehicle Assembly Building. Elements for three Artemis missions are on the way to KSC: core stage boat tail for Artemis II, core stage engine section for Artemis IV, and LVSA for Artemis II. The integration of abort capability into flight software algorithms has been the dominant development and verification activity for flight software development. The port assemblies for boosters are complete. The Orion Stage Adapter is complete and ready for shipment.

Artemis II baseline mission mode is circumlunar free return, which is different than Artemis I. The secondary payloads on Artemis II will be destined for Earth disposal. ICPS will put the

spacecraft into elliptical orbit around the Moon so there is enough time to validate the life support systems before committing the crew to free return.

### *Artemis III Progress*

ESM-3, which will power Orion to the Moon for the first landing mission of the Artemis test program, is ready to be shipped to KSC. The CM is in processing at the Neil Armstrong Operations & Checkout. The new configuration of the CM for Artemis III will include the NASA Docking System, which has had some major developments based on needs for Gateway and is ready for integration into the CM. ICPS is ready to go, LVSA is in the final phase of integration; all major barrel segments are structurally complete.

Two major programs are coming in to do flight testing on Artemis III. SpaceX Integrated Flight Test (SIFT) 4 was successful and informative; SIFT 5 will be in Fall 2024. There is crew support for the Human-In-The-Loop tests and lander avionics tests; integrated testing in mock-ups at Axiom and an elevator mock-up at Hawthorn have been done. Pad 2 is being readied for Earth departure capability. Axiom has augmented the design of the suit – which is very advanced, in particular the life support components – and is moving through Preliminary Design Review (PDR) and approaching Critical Design Review and manufacturing readiness.

The Joint EVA and Human Surface Mobility Test Team 5 Integrated Field Test will bring together all the teams that will be working together: flight crew on the surface, science teams, engineering teams. The goal is to maximize science on every flight and make sure the teams that are coming together are ready to do that work. It is also a great testbed for tools, integration, and hardware testing.

### *Artemis IV Progress*

Teams completed an inspection last week and are tightly partnered with ESA and Airbus for production cadence. The five barrel sections of the core stage and all four RS-25 engines are complete. At the Promontory Rocket Complex, large segments are cast and nozzles are being fabricated. Artemis IV is transitioning to a larger intended configuration of the space launch system. The payload adapter is an example of an in-house build at Marshall to give younger engineers a chance to develop a flight article for testing. The ‘Jack & Set,’ of the base of the ML2 to permanent mount locations was completed. All the commodity tanks needed for PPE, which will be used to keep the Gateway service module in service for 15 years, are at Maxar. Static load testing on the HALO primary structure was done at Northrup Grumman. Artemis IV will be using the SpaceX Starship as the landing solution, with design cycle PDR expected in spring 2025.

### *Artemis V*

There has been progress on the end of the test activity that the benchmark program has been asked to implement. Lunar Terrain Vehicle Service contracts have been awarded to three vendors. Lander teams are training together to develop design intuition. The CSA is building the Canadarm3 with advanced design for Gateway. The ESPRIT Refueling Module is being built in France. Partners at Mohammed bin Rashid Space Centre are excited to start evaluations for proposals for the Gateway Airlock. Blue Origin is making tremendous progress with Launch

Complex 36 complete, cryogenic and engine testing, and refurbishment of a test stand. The certification test series for the research engines are complete, delivery will be ahead of schedule.

### *Mars Campaign Office*

This is a technology development office to evolve technologies in 58 task areas across 5 domains. Mr. Kshatriya gave examples of recent accomplishments in areas such as growing food, crew conditioning (crews are coming back from ISS in great shape), ability for crew to have decision aids and to add more automation into control schemes, collaborating with industry and the agency in terms of deep sensing and other developments in the technology industry. The systems on a Mars transit mission are a must work. In addition to those activities, some development is being done in the monitoring of environmental systems on board the spacecraft.

Mr. Kshatriya reviewed the first Crew Health and Performance Exploration Analog (CHAPEA) Mars Mission analog. The crew lived inside the analog system for one year to understand crew health and performance. The experience included high-fidelity activities and routine biological and fitness assessments. There are many ideas for facility use for other system-level interactions.

Dr. Condon asked about the challenges associated with human exploration M2M and the current thinking on how best to protect the crew from radiation, particularly during transit phases. Dr. Siegel said that issue is on the agenda at the NAC/SOMD meeting. Mr. Kshatriya said there are extensive plans to instrument lunar missions to be able to characterize the environment the right way, including with different shielding. Lunar assets will be made available for that instrumentation and test campaign. Ms. Merancy added that, from the architecture perspective, that is a technology gap that has been identified.

Dr. Sowers asked whether M2M is planning to assess lessons learned from the Starliner investigation. Mr. Kshatriya said yes, starting with the flight and integration learnings from OD1 in 2019, there was an enhanced series of integrated tests and a critical events review. There are still efforts to get more higher fidelity ground test assets, but choices about prioritizing flight hardware versus ground test hardware have been necessary. There was much work done to emulate interactions between capabilities and conduct additional verification and validation activities at the interfaces. Ms. Koerner added that John McCullough, the Deputy for Integration, was assigned to follow the Crew Flight Test mission and he participates in discussions to make sure that information is captured for this organization.

Mr. Alibaruho posed an engineering process question regarding the mobile platform: given the damage and extraordinary effects that the rocket had upon launch, was the extent to which the platform would have to be overhauled anticipated or was it a surprise? Mr. Kshatriya said it is continuous learning: ML1 was built over many years for different design environments. As authorization and direction has changed, there has been a need to adapt the structure with the funding available to deal with potential environments. Proximate cause was related to having the correct nozzle exit environments from the launch vehicle and the understanding of the interaction of the plume with the structure; also, the modeling of the time series of the application of the load was challenging, so some guesses were made by Marshall, Ames, and KSC. The prediction of buckling and stress is an extensive computational problem, only a handful of people can be trusted, and it is still hard to get it right the first time. There was a cascading failure: the

application of the plume load led to a compromise of the pneumatic system (which should scrub the corrosive byproducts of the booster and the booster plume); because that system failed, the pad could not be purged, so all the areas that were not anodized or corrosion-protected corroded, which led to a lot of rework. A full recreation of the Computational Fluid Dynamics (CFD) has been done with the flight data and the structure can be made more rugged. The pad director has been able to figure out how to cut in the new developments and do the weld work and repair of systems. Mr. Kshatriya said that kind of learning is expected in a development program like this. The CFD has been validated by the teams at Marshall and the NASA Engineering and Safety Center (NESC). The learnings will be cut into the baseline designs for the ML2 and will ruggedize the same parts of the structure as was done for ML1.

Dr. Condon asked about CHAPEA: were there any big surprises or things that came out of that that were not anticipated? Ms. Koerner said the results have not been published and cannot be shared. They did stress a number of different characteristics of a mission, including things like unanticipated changes or anomalies in a mission that affect the crew's expectations that can then affect their performance. In some cases, they induce surprises to analyze the effect on performance.

Ms. Cline said, given the election year, she imagines a continuing resolution (CR) is likely and asked whether there were any other budget concerns. Ms. Koerner said she thinks a CR is likely, too, and preparations have started in anticipation of what the government may do and whether they will have a budget or not. There is not a lot of difference between what was executed in FY 2024 and plans for FY 2025 in terms of near-term milestones; if it is an extended period of time that clearly will impact what can be accomplished. A great example is the evolution of the ML, which was built for one program and continuously modified for other programs; any time there is a CR it is like having a modification to the budget profile on those programs. It means the programs are not executing to optimal plan; they are in standby mode. This program, since the charge to go back to the Moon, has been in a CR nearly 50% of the time, so it is familiar territory.

Ms. Budden commented that NASA gets criticized about budget and it seems to her that NASA is doing incredible work towards reusing things like the ML and the crawler and lunar infrastructure. She wondered whether there is a way to communicate this effectively to the right people, whether Congress, public, or other people to show off that NASA is saving through reuse and repurposing. It is a good story and perhaps the Public Affairs Office could use it to get ahead of conversations about the return to the Moon being too expensive. Ms. Koerner said those conversations are being had. The value that Artemis and NASA bring to not just local economies but the global economy is something that is highlighted on a regular basis: cutting edge activities on a shoestring budget and efforts to capitalize on and take advantage of the resources that currently exist to maximize value for taxpayer. It also shows up in terms of the audits on programs; currently there are eight or nine different audits between all programs across the Government Accountability Office (GAO) and the Office of the Inspector General (OIG); within those audits, detailed information is provided about how much effort goes into using those resources and tracking them to make sure to get the most value for the American people. Ms. Budden added that there is also value within NASA and that probably helps the particular directorate look better and potentially compete better for internal funding. Ms. Koerner said she

has set as a goal to be very open and transparent with stakeholders with budget and structure. The President's budget request was favorable for all ESDMD programs, including the M2M. There was discussion of the actual number of audits and acknowledgement that they take significant resources; the audits are valued to ensure good stewardship, but tracking has begun for the number of hours and products delivered for the investigations that are ongoing. One audit took 1,100 hours and Ms. Koerner said some audits extend for years and require extensive data deliveries in the 100s or 1000s. She took as an action to give the committee specific tracking information. Ms. Budden said that a year or more ago, the subcommittee had a finding or recommendation about these audits taking too much time and it being detrimental to progress on other fronts. There was discussion about what happened to that recommendation. Dr. Siegel recalled the recommendation and said she would check on it.

Mr. Voss asked whether all the technical issues for Artemis II have been closed. Mr. Kshatriya said there are a handful of things outstanding, primarily on the spacecraft. A lot of the decisions made in the early days of development for Orion and the Space Launch System were decisions about manufacturing flight hardware, there was a lot of flight acceptance ahead of qualification. Design and performance margins had to be checked out of the system. That has caused a lot of issues as seen recently, for example, with the Crew Module Battery. So there are a lot of designs that are fixed in the subsequent vehicles not fixed in the current vehicle and they need to be retrofitted: the battery, the digital motor controllers, the heat shield (a new finding from Artemis I). The main point is that a mode must be reached where lessons learned can be applied and incorporated as progress is made toward crewed flight. The baseline mission mode for Artemis II is simpler than Artemis I – with Artemis I, there was a lot of risk taken and the vehicle was pushed to the edge of its performance envelope (e.g., with long duration lunar orbits, aggressive reentry speeds, testing and attitude maneuvers to shake down the extent of the thermal performance for inflight data). For Artemis II, the mission mode is relatively straightforward and risks are not desired: every burn and maneuver needs to result into a failsafe configuration. Mr. Kshatriya said when an organization transitions from un-crewed to crewed flight, many learnings come out of production development activity. It also requires a cultural mentality and organizational maturity, which is coming out with the progression.

Dr. Paul McConnaughey asked about budget and flexibility and moving funds across appropriation lines. What is the current level of institutional taxes on this budget and how is that affecting the ability to get funding to the programs? Ms. Koerner said, in the current year, it is manageable, but there is cost growth in every sector, and there is movement closer to full cost accounting. Things purchased at marginal cost previously are not at full cost. Institutional and mission support organizations are increasing costs to individual programs to do basic execution. And, NASA has embarked on NASA 2040, looking at where the agency needs to be in 2040 to support programs in the portfolio; the realization of that investment to make that happen begins a little in 2025 and is mostly in 2026. Those institutional investments are resulting in increased overhead to handle aging infrastructure. Mr. Kshatriya talked about the refurbishments that have been needed and the infrastructure that needs to be updated and maintained over time: the resources available to do that, from an agency perspective, have not kept pace with the programs themselves. So there is an increase in the need to be able to fund some of that activity and it starts to impact in the 2026 timeframe and varies year to year. It ends up being somewhere between 2% and 5% of the portfolio.

Ms. Cline asked how infrastructure investment is prioritized with regard to program needs and requirements. How do you stand on getting an interaction and your priorities into that consideration? Ms. Koerner said priorities are provided, but the process is managed at an agency level by the Mission Support Directorate, so she would defer to the mission support organization or agency leadership on how they are prioritizing those investments.

Mr. Voss noted that, in October 2022, there was discussion about a finding on that. Dr. Siegel said she would look. Ms. Cline said she took all findings that had been collected and not yet presented to last full NAC meeting she attended and did not remember that being one. She added that the concern might have been that it was bigger than a committee petition to the MD. Mr. Wayne Hale may have decided not to take it forward. Dr. Siegel said, even for the ones that were presented, HEOC never found out if they were accepted. Ms. Cline said that, apparently in the past, the NAC had their own separate vote on findings and recommendations and then went back to the MDs. There was a request from the SMD that, for findings and recommendations directly to the MD, they wanted to see them without waiting for approval by NAC. The chairman, Lester Lyles, was taking that into consideration. In fact, many findings and recommendations had not gone through the full process up to that point, because NAC had not been meeting. Ms. Cline will follow up to see where things stand.

#### Discussion

Ms. Cline reconvened the meeting after a break and asked for comments on the morning session. Dr. Ellen Stofan expressed concern about what was being heard about the many and complicated developments. She said the schedule seems to be at risk and perhaps that could be turned into a finding. Ms. Cline said schedule was not on the risk list because it is well understood to be a risk and they are tracking a lot of technical aspects. Dr. Stofan would still like to focus on schedule as a risk. She said there are a lot of individual technical risks but, put together, there is an integrated schedule, so you can solve each technical risk and still get into schedule trouble. Dr. Sowers thought the issue of the schedule being at risk would be a good finding. He thought a chart with all the different Artemis missions on a timeline was important to get a sense of everything in one place and that without that it is hard to know that they are even committed to a schedule. He got the sense that the dates were big and just best efforts without a real plan. Ms. Cline offered to give feedback that the committee would like to see that chart routinely. Mr. Alibaruho said there are some show stopper technical issues being worked on and HEOC knows they have a schedule and are tracking schedule risks. They will not fly until they know it is safe. He was hesitant to talk about this as a finding and suggested it might be the style of presentation, that they wanted to emphasize safety and technical rigor over timeline.

Mr. Ebersole asked whether there was a cost performance index, schedule performance index criteria where they actually quantify their execution, but it was not in the deck for this meeting. Dr. McConnaughey said he asked for that at the last meeting. And specifically the HLS program asked them and they have done the complete dispersions – a confidence level schedule and joint budget, a rigorous schedule analysis and disbursed the risk and it has been approved by the agency. Dr. Condon said this is a result of the division of the mission directorate into exploration systems development and operations. The schedule Dr. Sowers referred to has been an operational one in the past, that shows various launch times that are planned; but there is also a

development schedule. Those two are separate entities. He said it would be helpful in these presentations to see what the planned launch schedule is; in some sense, that is tied to the development schedule. There is a difference between a development schedule and an operational schedule. It was agreed upon that this was not a finding but a request to see this in future updates. Dr. Condon said it would be helpful to see the operational schedule and the development schedule.

### Public Comments

Ms. Cline called for public comments. Dr. Siegel notified the public to put their comments in the chat so they could be read to the committee.

*Comment from Gene Mikulka via chat: On the architecture, when the whole process started some years ago, it wasn't all that clear on how the architecture works to us non-technical folks. Today's presentation by Nujoud Merancy triggered an epiphany of sorts on the approach and finally the pieces fell together. I saw what a complex undertaking this really is and that those involved are really "sweating the small stuff," as they should on that level. Was gratifying to hear. Also appreciated Cathy Koerner's remarks on the Continuing Resolution dangers and that, somehow, even being under a CR 50% of the time, things are getting done. Just wish I heard more about the reaction to the NASA IG's Mobile Launcher-2 report, more on the progress of both HLS craft, and any additional insight of the Orion heat shield issue and its progress toward resolution.*

Ms. Cline said she had the same reaction on the architecture the last time it was presented, specifically how thorough it was and having an iterative process going down. She thinks progress is being made on the heat shield but there is still some final work. The OIG Report was not addressed on the ML. The current status on the Orion heat shield was provided in the presentation: the technical teams and other folks that have been doing the assessment are wrapping up their work, but the assessment process is ongoing to determine the path forward, and there is a desire to make sure there is a clear path before it gets communicated.

### Discussion and Recommendations

Ms. Cline displayed the finding about the audit from a previous meeting. She reviewed the suggestion of the finding, namely that the number of audits that continue to come in are an impact on the program (Short title: Audit Burden on NASA Mission Directorates) and wondered whether it should be plural for multiple directorates. She read the finding to the attendees: "Multiple external audits imposed on NASA mission directorates adds substantial burden to staff and take time away from critical program work. They require thousands of hours to gather information and write responses that consume organizational resources. NASA mission directorate personnel will have less time than needed to work on mission critical tasks, potentially causing program delays or resulting in failure to complete the tasks." She said there is an alternate version that would be a recommendation and asked the committee for input. Mr. Alibaruho suggested adding the idea that the committee agrees with and supports independent assessment of stewardship, but the real message is the level of audits that have been requested have grown to the point so it is a significant portion of the teams' overall work and it may challenge their ability to deliver. He wanted the message to convey acknowledgement that the audits may be counterproductive. Ms. Cline and Ms. Budden discussed language to capture that



and Ms. Cline said she had “We recognize the value of audits to ensure the agency is a good steward of public funds.” Replying to a question, Dr. Siegel said, in her understanding, findings and recommendations both rise to the level of Administrator, but findings do not require a response and recommendations do. Ms. Cline said she reported on both levels in the full NAC meeting which has some representation from the Administrator’s office. Dr. Condon said constructive action will have to come as a result of leadership from the Administrator and will require action on the Administrator’s part in working with the Office of Management and Budget and the Congressional committees and possibly the National Space Council; those are the only entities that have sway or influence on the organizations that are conducting all of the audits. There was discussion about findings versus recommendations and to whom this particular issue would be addressed. Dr. Budden wanted a recommendation because it would be actionable.

Dr. Sowers said the recommendation should be the NASA Administrator work with the audit agencies to minimize the impact of the workforce while meeting the objectives of the audit. Mr. Voss suggested that someone should tell them not to audit unless they are directed to do it by Congressional mandate or administrative/presidential mandate. Dr. Sowers said the legal mandate of organizations like the GAO is to provide insight and oversight, visibility, and accountability across the board. Dr. McConnaughey said they are starting to expand their scope into technical judgment and something needs to be said about expanding scope beyond waste, fraud, and abuse because things are being done outside the audit scope. Ms. Cline agreed and mentioned the reference to Aerospace Safety Advisory Panel (ASAP); she asked whether there is value in commenting that there are certain areas that ASAP is investigating on a routine basis and duplication is unnecessary. Dr. McConnaughey added that when the GAO releases some technical judgment, the press takes it and sensationalizes it. The scope creep on the audit side from these offices needs to be constrained or highlighted as potentially harmful to the programs – it is not just a time issue, but it could be technically wrong. There was agreement to work as a group offline for wording about the value and impact of these audits.

Dr. McConnaughey suggested a finding or recommendation about the 2%-5% impact on budget that institutional tax will have on ESDMD. He said it is pretty high and is moving away from full cost accounting. If the public and Congress are holding the program accountable for performance, the program should have control of the money – its own budget line – to execute relative to performance expectations. Ms. Cline said there was a brief discussion of this in the public meeting. Mr. Voss noted it was one of the things Ms. Koerner wanted help on. Dr. McConnaughey said there are many fixes and Congress could get annoyed by it and make their own decision and provide feedback to the stakeholders. He thought it should be a finding that a 2%-5% budget impact would be detrimental to program performance. He said a recommendation could be a separate budget line, but a lot of people would oppose putting it out there for concern that it be targeted. Ms. Cline said it could be a finding of concern about the impact without suggesting how it gets fixed (e.g., more money, which is not in the committee’s control). Dr. McConnaughey said the Administrator could propose more money or establish a separate budget line. If the objective is performance for public and Congressional expectations, the public and Congress would want to know what a NASA institution really costs. Dr. McConnaughey clarified that he was talking about NASA 2040. Ms. Cline said the NASA 2040 plan would start hitting in 2026, so it is not the immediate impact, it is looking at the future and managing then. Ms. Cline suggested this be written up as a finding and the committee could wordsmith it offline.

Dr. Condon said the committee could ask for a more detailed presentation on the NASA 2040 project so there is a more complete understanding of the details of the infrastructure upgrade and what the costs are. Then, the committee might be in a better position to propose a finding or a recommendation for the project. It was noted that this topic was not on the NAC agenda for October 2024. Mr. Voss said these types of funds should come from a line item in the NASA budget that is for construction facilities, instead of from the programmatic funds. Ms. Cline said this is familiar because infrastructure investments are frequently where cuts to the budget come from, a cascading backlog of investment in the infrastructure. Dr. McConnaughey said he thinks the 2024 funds are also being used to address other activities, such as the funding of education and IRAT. Ms. Cline asked whether HEOC wanted to try to comment on this now or understand a little bit more about 2040 before commenting. Dr. Condon would prefer to have more information about the details of the program, the costs, and assuming that the funding comes from programs, what those program impacts are, before providing a finding or recommendation. Ms. Budden agreed and was also interested in seeing the level of detail that has been fleshed out. She said there may be internal struggles between the different components within NASA so she would like to see that before the committee weighs in. Ms. Cline said some of this may be naturally embargoed because it is part of a budget formulation. Ms. Budden said that ‘keeping an eye on the infrastructure capability investment’ led her to believe it was limited to infrastructure for the future, but that leaves out other pieces: what infrastructure will be repurposed and other parts of the programmatic that are not included. Ms. Cline thought it was general enough not to be clear and said NASA 2040 would stay on the list of things to learn more about. Ms. Budden said that gets back to the charts in light of schedule, specifically the charts that show what is launching from the Earth on the bottom and what is landing on the Moon on the top, with dates and launch vehicles marching across the page and shows the whole program; it would be interesting to see that chart for 2040, but it may not exist at this point.

Ms. Cline called for other thoughts on findings and recommendations. There were none.

Ms. Cline said the next meeting would be 17 September with the SOMD. The next full NAC meeting is 1 and 2 October. HEOC will decide offline when to have a future meeting. There is a desire to get down to JSC for that.

Dr. Condon suggested a potential item for a future meeting: He wants to see examples of how the strategy and architecture work is being used. What actions is that work driving in other areas of the program? Activities like those presented sometimes have the risk of becoming an end unto themselves, which is not the intent. So a few examples of how their products are being used, influencing other organizations, or being developed in other organizations would be helpful.

Timing and schedule for future meetings was discussed. Dr. Siegel suggested that, because it is an election year, the next HEOC meeting probably will not be until Spring. There was further discussion about the implications of election year changes. Dr. Condon suggested that Ms. Koerner should decide when to have the next meeting. There was general agreement. Mr. Ebersole said it would be nice if Ms. Koerner provided more demanding expectations of what she wants from HEOC; how, specifically, can the committee help her? Mr. Alibaruho sought to clarify the committee’s charter to provide advice to the Administrator, with the AAs as points of

contact for information and questions, but the Administrator was the ultimate customer. Dr. Siegel validated that HEOC serves as advisors to the Administrator but can specify to whom findings and recommendations go. Mr. Voss said, in the last 5 or 6 years, there has been a shift from direct communication to the Administrator to the AA, and the committees became more interactive with the directorate heads, the AAs, because the Administrator was getting inundated. Dr. Siegel agreed. Ms. Budden offered a different perspective and suggested it has varied with the specific Administrator and their personality and desire to meet with the NAC subcommittees or the NAC. It is highly likely in an election year to get a new Administrator. The work needs to continue; if there is no Administrator or there is a wait for an appointment, definitely go to the AAs.

Mr. Voss asked whether the person who requested more information on the propellant transfer in orbit, the cryo transport information was satisfied with the information received. Dr. Sowers said it could have been him and he knows more about it than he did before and feels he learned all they will say; the details are likely SpaceX proprietary.

Ms. Cline took an action to see if HEOC's two AAs would like a meeting sooner than late spring. She will circulate a draft of the proposed recommendation to get help wordsmithing. She would like to have it done in time for her to present at the next NAC meeting, 1 and 2 October, so it can get into the queue for NAC to look at.

Dr. Siegel thanked all the meeting participants and the staff who helped during the meeting and with set up. She adjourned the meeting at 2:27 pm.

**NASA ADVISORY COUNCIL**

**Recommendations and Findings:**

**August 29, 2024**

**ESDMD Session**

**For NAC Recommendations (actionable):**

**Short Title of Recommendation:** Audit Burden on NASA Mission Directorates

**Recommendation:** Recommend that the NASA Administrator seek relief from the burden of multiple external audits by asking the Administration and Congress to restrict organizations within their purview from performing audits unless specifically required by law.

**Major Reasons for the Recommendation:** Although we recognize the value of audits, multiple external audits imposed on NASA Mission Directorates add substantial burden to staff and take time away from critical program work. They require thousands of hours to gather information and write responses that consume organizational resources.

**Consequences of No Action on the Recommendation:** NASA Mission Directorate personnel will have less time than needed to work on mission critical tasks causing program delays.

**Appendix A**  
**Council Membership**

Ms. Lynn Cline, Interim Committee Chair  
*Former NASA Deputy Associate Administrator for Human Exploration and Operations*

Ms. Nancy Ann Budden  
*Director for Special Operations Technology, Office of the Secretary of Defense*

Dr. Stephen “Pat” Condon  
*Aerospace Consultant, former Commander of the Ogden Air Logistics Center, the Arnold Engineering Development Center, and the Air Force Armament Laboratory*

Mr. Michael Lopez-Alegria  
*Former NASA astronaut and retired U.S. Navy Captain, President of the Commercial Spaceflight Federation*

Mr. James Voss  
*Former NASA astronaut and retired U.S. Army Colonel, Scholar in Residence, Department of Aerospace Engineering Sciences, University of Colorado, Boulder*

Mr. Kwatsi Alibaruho  
*Vice President, Program Management – Industrial Sector Eaton*

Dr. George Sowers  
*Professor at the Colorado School of Mines*

Mr. C. Douglas Ebersole  
*Former Executive Director, Air Force Research Laboratory*

Dr. Ellen Stofan  
*Under Secretary for Science and Research at the Smithsonian Institution*

Dr. Paul McConnaughey  
*Former Deputy Center Director; Associate Director, Technical; Associate Director Marshall Spaceflight Center*

**Appendix B**  
**Attendees**

Human Exploration Operations Committee

Mr. Kwatsi Alibaruho, Industrial Sector Eaton  
Nancy Ann Budden, Special Operations Technology, DoD  
Lynn Cline, NASA HEOMD, ret.  
Pat Condon, Aerospace Consultant  
Doug Ebersole, Airforce Research Lab, ret.  
Paul McConaughy, NASA Marshall Space Flight Center, ret.  
Bette Siegel, Executive Secretary, NASA  
George Sowers, Colorado School of Mines  
James Voss, University of Colorado, Boulder

Webex Attendees

Alanna Carnevale	Danny Baird	Jessica Clarke
Alexia Constanza	Danny Lentz	Jessica Ende
Allen Cutler	Dave Huntsman	Jim Broyan
Andrew Sais	David Millman	Jim Reuter
Ashlee Wilkins	David Read	John Martens
Ashley Peter	DeAnn Reilly	John McCullough
Audrey Morris-Eckart	Deanna Whitehead	John Mcmanamen
Barbara Stacey	Denise Pham	Jose Ramos
Benjamin Neumann	Eddie Semones	Joseph Sessa
Bev Perry	Ellen Stofan	Joseph Vermette
Beverly Casillas	Eric Berger	Juli Steinhouse
Bill Stiers	Erik Torres	Julia Mules
Brian Harvey	Erin Kennedy	Julie Grantier
Carol Hamilton	Erin Stuart	Karin Sturm
Caroline McCullough	Francesco Bordi	Kate Kubicek
Catherine Williams	Gale Allen	Katie Frakes
Cathy Baroang	Gayle DiBiasio	Kendra Kastelan
Charles Blue	Gene Mikulka	Kiersten White
Chelsea Trainor	Heather D. Smith, M.S.	Kira O'Sullivan
Chris Gilbert	J.A. Ramos	Kirsten A
Clark Thompson	Jack Kiraly	Kristin Van Wychen
Corinne Beckinger	Jack Kuhr	Lakiesha Hawkins
Corneilius Robinson	Jacob Bleacher	Laura Forczyk
Dacia Bruns	James Green	Laura Means
Dae'Vion Harris	Janine Harris	Linda Dao
Dan Huot	Jason Jones	Lindsay Aitchison
Dana En	Jeanette Edelstein	Lisa Allen
Dani Strong	Jeff Foust	Lisa Watkins
Daniel Mazanek	Jennifer Kunz	Lora Bleacher

Lori Garver  
Maddy Davis  
Marcia Smith  
Marlana Dorman  
Martha Hess  
Mary Christian Chester  
Mary Engola  
Matheiu Gagnon, CSA  
Matthew Ramsey  
Michael Ching  
Michael Deklotz  
Michael Frazier  
Michael Waid  
Mike Hemrich  
Miles Doran  
Nantel Suzuki  
Nathan Tat  
Patricia Moore  
Philip Sloss  
Qawi Robinson  
Rachel Kraft

Ramzi Masri  
Ray Lundquist  
Reagan Hunter  
Rebekah Whitten  
Ruthan Lewis  
Ryan Schaefer  
Samina David  
Sara Wood  
Sean Thompson  
Shane Canerday  
Sheela Logan  
Shermane Martino  
Sherrica Holloman  
Stacie Maloy  
Stan Schaefer  
Stephan Gerard  
Stephanie Schierholz  
Stephen Clark  
Stephen Davison  
Steve  
Steve Koerner

Stratis Catacalos  
Tammy Flowers  
Tara Polsgrove  
Tariq Malik  
Timothy Hartman  
Timothy Lewis  
Tonya Woodbury  
Tsulon Lee  
Tudy Lau  
Valerie Chabot  
Vanessa Lloyd  
Veronika Fuhrmann  
Victor Alvarez  
Victor Schneider  
Wayne Hale  
Will Bryan  
Will Drexler  
William Hicks  
Zoe Wai

**Appendix C**  
**Agenda**

*Thursday, August 29, 2024*

**NAC HEO Committee Public Meeting – Exploration Systems Development Mission Directorate**

- 9:30-9:35**      **Opening Remarks**  
Bette Siegel, NAC HEO Executive Secretary  
Lynn Cline, NAC HEO Chair
- 9:35-10:00**    **Exploration Systems Development Mission Status**  
Catherine Koerner, Associate Administrator for Exploration Systems Development
- 10:00-10:45**   **Strategy and Architecture**  
Nujoud Merancy, Deputy Associate Administrator, Strategy & Architecture Office
- 10:45-12:15**   **Moon to Mars**  
Amit Kshatriya, Deputy Associate Administrator, Moon to Mars Program
- 12:15-1:30**    **Lunch**
- 1:30-1:40**      **Public Comments**
- 1:40-3:00**      **Discussion and Recommendations**
- 3:00**            **Adjourn**



**Appendix D**  
**Presentations**

1. Exploration Systems Development Mission Status, *Catherine Koerner*
2. Strategy and Architecture, *Nujoud Merancy*
3. Moon to Mars, *Amit Kshatriya*