

NASA Advisory Council
National Aeronautics and Space Administration
Washington, DC 20546

General Lester L. Lyles (USAF, Ret.), Chair

November 26, 2019

Mr. James F. Bridenstine
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Administrator ~~Bridenstine~~ Jim

The NASA Advisory Council held its second public meeting of 2019 at NASA Kennedy Space Center on October 31 – November 1, 2019. We have held only two Council meetings this year due to the impact of the U.S. Government shutdown earlier this year.

As a result of our deliberations, and in accordance with our "two-tier" approach for transmitting recommendations and findings to the NASA leadership, the Council approved three Council recommendations and five Council findings for your consideration (enclosed). The Council also approved one Committee recommendation and two Committee findings for consideration by the respective NASA Associate Administrators. Copies of the latter also are enclosed for your information and awareness. If you have any questions or wish to discuss this further, please do not hesitate to contact me.

I look forward to discussing these recommendations and findings with you in the future.

Sincerely,


General Lester L. Lyles (USAF, Ret.)
Chair

Enclosures

I hope to meet with
you and Jim Morhard
after the Thanksgiving
holidays!
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NASA Advisory Council Recommendation

Human Lunar Lander Development for Safety 2019-02-01 (HEOC-01)

Name of Committee: Human Exploration and Operations Committee

Chair of Committee: Mr. Wayne Hale

Date of Council Public Deliberation: October 31, 2019

Short Title of Recommendation: Human Lunar Lander Development for Safety

Recommendation:

NASA should review, with an acceptable team, the requirement for in-flight testing of the Human Landing System. Serious consideration should be given to demonstrating through flight test the ability to deorbit, land on, and ascend from the lunar surface under the expected physical and environmental conditions.

Major Reasons for the Recommendation:

A critical step in the development of the Human Landing System is the plan for human flight certification and its execution. While there may not be a single correct or acceptable approach, systems developed for human space flight in the past have found that uncrewed end-to-end flight tests have been extremely valuable. Partial or ground testing may be options but the Council strongly recommends flight testing.

Consequences of No Action on the Recommendation:

Inadequate design may not be uncovered prior to human use.

NASA Advisory Council Recommendation

Longevity of the International Space Station 2019-02-02 (HEOC-02)

Name of Committee: Human Exploration and Operations Committee

Chair of Committee: Mr. Wayne Hale

Date of Council Public Deliberation: October 31, 2019

Short Title of Recommendation: Longevity of the International Space Station

Recommendation:

The Council recommends that NASA perform an analysis of the safe and useful life of the International Space Station (ISS) past 2028 with emphasis on the structure and other critical systems that cannot be replaced on orbit.

Major Reasons for the Recommendation:

An engineering analysis has been performed that shows that the ISS can operate safely until 2028. The Council believes a Low Earth Orbit (LEO) platform to continue research for deep space, long duration missions will be needed past 2028. Enabling commercial LEO platforms and services should remain NASA's goal, but the Agency should understand the safe remaining life of the ISS in case the commercial platforms and services are not available by 2028.

Consequences of No Action on the Recommendation:

NASA will not have the critical information necessary to making an informed decision about ISS life extension.

NASA Advisory Council Recommendation

Principles on Space Resources 2019-02-03 (RPC-01)

Name of Committee:	Regulatory and Policy Committee
Chair of Committee:	Mr. Michael Gold
Date of Council Public Deliberation:	October 31, 2019
Short Title of Recommendation:	Principles on Space Resources

Recommendation:

The Council recommends that NASA, in coordination with the National Space Council, work with the Departments of State, Commerce, Transportation, and Defense, to formulate and adopt specific principles, guidelines, rules and regulations, as appropriate, that address the extraction and utilization of space resources. Furthermore, the Council recommends that NASA, in coordination with other Federal entities as appropriate, advocate for the global adoption of such principles by additional countries and international bodies.

The Council has crafted initial Principles *for the Administrator's consideration* which are provided below as Annex A:

Annex A: Principles on Space Resources

Principle 1

Abiotic space resources (or simply “space resources”) shall be extracted in a manner that fully complies with the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies. In this context, the term “extraction” includes but is not limited to (i) the extraction of resources from the interior of a celestial body and (ii) the recovery of resources from the surface of a celestial body.

Principle 2

The extraction of space resources should be conducted in a manner that takes into account the United States’ commitment to the United Nations Guidelines for the Long-term Sustainability of Outer Space Activities.

Principle 3

The extraction and utilization of space resources does not constitute national appropriation under Article II of the Outer Space Treaty.

Principle 4

Per Article VI of the Outer Space Treaty, States shall authorize and supervise the extraction of space resources from celestial bodies.

Principle 5

States' domestic laws should facilitate government and non-government extraction and utilization of space resources as well as the ownership of those resources.

Principle 6

The principle of due regard, consistent with Article IX of the Outer Space Treaty, should be taken into account by any State authorizing the extraction of space resources. If the State responsible for authorizing the extraction of space resources has reason to believe, based on the information described by Article XI, such activities would result in harmful interference, consistent with Article IX, the State shall engage in consultations with the affected States.

Principle 7

States shall share scientific information with the international community resulting from activities related to space resource extraction and utilization, to the greatest extent feasible and practicable, on a good-faith basis, and in compliance with national laws, including but not limited to export controls as well as protections for intellectual property and national and commercially sensitive data.

Principle 8

States shall inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, in compliance with national laws, including but not limited to export controls as well as protections for intellectual property and national and commercially sensitive data, regarding the nature, conduct, and location(s) of authorized space resource extraction activities. States shall also provide timely notice to the Secretary-General of terminated space resource extraction activities.

Major Reasons for the Recommendation:

The ability to extract and utilize space resources is critical to the success of Artemis specifically and the future of both public and private space exploration and commerce generally. NASA, in collaboration with the Departments of State, Commerce, Transportation, and the National Space Council, needs to ensure that the U.S. has a clear policy enabling extraterrestrial resource extraction and utilization that can serve as a model for other countries as well as international bodies such as the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS).

Consequences of No Action on the Recommendation:

If NASA does not lead by example, foreign countries, the UN COPUOS, and/or other international bodies, may adopt conflicting or different policies that could create barriers to or even deter investment in the extraction and utilization of extraterrestrial resources. Moreover, the lack of a clear and consistent global policy could result in unnecessary confusion and potentially conflict over space resources.

NASA Advisory Council Finding

Supporting the Artemis \$1.6 Billion Proposed Budget for FY 2020

Name of Committee: Human Exploration and Operations Committee

Chair of Committee: Mr. Wayne Hale

Date of Council Public Deliberation: October 31, 2019

Short Title of Finding: Supporting the Artemis \$1.6 Billion Proposed Budget for FY 2020

Finding: The Council believes that NASA has done a credible job estimating the FY 2020 funding total for Artemis to meet its goals for 2024. \$1.6 billion is considered a reasonable estimate of the first-year costs toward the 2024 landing. The Council acknowledges that even with the full FY 2020 funding request of \$1.6 billion, accomplishing planned activities by 2024 will be aggressive, challenging and difficult. The Council applauds NASA for not raiding other Mission Directorate budgets to fund the Artemis program. An aggressive drive toward the 2024 deadline has prompted a sense of urgency within NASA to meet its goal. Programs, hardware and deliverables are proceeding at a rare pace since Apollo, on or ahead of schedule. Related technology advances are proceeding rapidly. We believe proceeding without this funding level in FY 2020 will result in significant risk to schedule. Additionally, funding should be provided in a timely manner in order to avoid schedule slip and to maintain the current impressive momentum within the program. The Council therefore endorses the FY 2020 and follow-on budget request and recognizes it to be the top priority and threat to the success of the Artemis program.

NASA Advisory Council Finding

NASA Competing with Industry in Human Space Flight Commercialization

Name of Committee: Human Exploration and Operations Committee

Chair of Committee: Mr. Wayne Hale

Date of Council Public Deliberation: October 31, 2019

Short Title of Finding: NASA Competing with Industry in Human Space Flight Commercialization

Finding: NASA has unparalleled brand value and significant resources with which nascent industry entities in the commercial Low Earth Orbit (LEO) market are unable to compete for the same potential customers. NASA's recent initiatives to stimulate demand for a LEO market for which it will be one of many customers are laudable. But care must be taken to prevent unintentional consequences. For example: highly subsidized rates for accommodations aboard the International Space Station for Private Astronaut Missions may stimulate demand in the short term, but the ability to simply "purchase" these accommodations from NASA will not facilitate acquisition of the knowledge necessary for longer term operation in LEO by non-NASA platform providers. If NASA provides a heavily subsidized fee-for-service option leading up to the transition from a government to commercial platform, the operating entity will not have gained the necessary knowledge and experience to independently keep astronauts safe and well during their stay.

NASA Advisory Council Finding

Near-Term Schedule Goal – Human Landing on the Moon by 2024

Name of Committee:	Human Exploration and Operations Committee
Chair of Committee:	Mr. Wayne Hale
Date of Council Public Deliberation:	October 31, 2019
Short Title of Finding:	Near-Term Schedule Goal – Human Landing on the Moon by 2024

Finding: The setting of a near-term schedule goal (human landing on the Moon by 2024) has led to a change in the culture and streamlined decision-making, new acquisition methods, etc., and should be maintained, even if the schedule slips.

NASA Advisory Council Finding

Launch Services Program

Name of Committee:	Human Exploration and Operations Committee
Chair of Committee:	Mr. Wayne Hale
Date of Council Public Deliberation:	October 31, 2019
Short Title of Finding:	Launch Services Program

Finding: The service attitude and culture of the Launch Services Program are commendable to build a team that collaborates with multiple parties to achieve a launch goal. The Council believes that the Artemis program (all the elements such as Space Launch System, Orion, Human Landing System, Gateway, et al) should study the way the Launch Services Program operates and use the applicable processes, attitude and culture as much as is practical.

NASA Advisory Council Finding

Space Resources

Name of Committee:	Regulatory and Policy Committee
Chair of Committee:	Mr. Michael Gold
Date of Council Public Deliberation:	October 31, 2019
Short Title of Finding:	Space Resources

Finding: Long-term success in human space exploration by both public and private entities will require the use of extraterrestrial resources. Specifically, the utilization of space resources is critical to the success of Artemis as well as private space exploration and commerce generally. The U.S. needs a clear, comprehensive legal and regulatory framework to guide the extraction and utilization of these space resources. Such a U.S. policy can serve as a model for other countries and as a foundation for the international framework required to establish a clear and consistent global policy that is needed to avoid international confusion and potentially conflict over space resources.

NASA Advisory Council – Committee Recommendation

Aeronautics Committee Recommendation to NASA Associate Administrator for Aeronautics Research Mission Directorate

Propulsion Transformation – Electric Propulsion

Name of Committee:	Aeronautics Committee
Chair of Committee:	Mr. John Borghese
Date of Council Public Deliberation:	November 1, 2019
Short Title of Recommendation:	Propulsion Transformation – Electric Propulsion

Recommendation:

The Aeronautics Committee applauds NASA's research in Electrified Aviation Propulsion. Research is being performed in many relevant areas: aero efficiencies, compliance and certification, tools for better design trades and new materials such as insulators. The Committee recommends that NASA consider developing and maintaining a database of battery and cell test results to share with industry. The idea is to have an energy power storage (e.g., cells, batteries, etc.) laboratory within the current NASA infrastructure dedicated to testing specific electric aircraft propulsion. This lab would test against standardized protocols and make the results available to industry to accelerate the adoption of electrified powertrains. This approach could be expanded to other system components, such as power electronics in the future. The Committee further recommends that NASA explore other promising aircraft electric propulsion technology alternatives, such as fuel cell variants currently in use in automobile and bus transport vehicles. There are potential applications to the Mars mission so it will benefit not only the Aeronautics Research Mission Directorate but also NASA as a whole.

Major Reasons for the Recommendation:

Both large and small innovative companies in the emerging electric aircraft industry are struggling to solve the energy storage problem. While significant progress is being made in the electric motors and lift systems, battery capacity with safe and efficient integration into air vehicles remains the critical component for success. Significant research is being performed at the University level. However, the immense challenge of transitioning these battery technologies is accomplished at very few manufacturing companies due to the difficulty of achieving large-scale consistent manufacturing processes at scale. These manufacturing companies do not readily reveal their latest cell capability to small companies. Other electric propulsion alternatives suitable for aircraft applications (i.e., lightweight, high power/energy density) are in early stage development. NASA can fill this critical gap by providing a reasonable, credible, and consistent testing methodology that industry can access. Other electric propulsion alternatives suitable to aircraft applications (i.e., lightweight, high power/energy density) are in early stage development. NASA could provide a test bed capability for these emerging technology

capabilities, providing significant value to the emerging U.S. electric aircraft marketplace. The country wants to lead in this technology area and the value to the U.S. economy is tremendous.

Consequences of No Action on the Recommendation:

The lack of extensive testing on new battery cell and other emerging electric propulsion technologies, along with the lack of supporting data will impede the small electric aircraft industry from developing the most efficient vehicles for this emerging market.

NASA Advisory Council – Committee Finding

**STEM Engagement Committee Finding
to NASA Associate Administrator for
STEM Engagement**

Study on Sparking Interest in STEM

Name of Committee: STEM Engagement Committee

Chair of Committee: Dr. Aimee Kennedy
(presented by Mr. Daniel Dumbacher)

Date of Council Public Deliberation: November 1, 2019

Short Title of Finding: Study on Sparking Interest in STEM

Finding: The STEM Engagement Committee appreciates the work done to understand the generation and sustainment of “sparking” interest in STEM areas. The expert panel review and literature search provided valuable input to STEM Engagement Strategies. The “Spark” study conducted by the Office of STEM Engagement (OSTEM) provides important knowledge and information for future STEM activities planning. The Committee looks forward to seeing the results of the action requesting OSTEM to develop a prioritization strategy for addressing the findings from the Spark study at a future Committee meeting.

NASA Advisory Council – Committee Finding

**STEM Engagement Committee Finding
to NASA Associate Administrator for
STEM Engagement**

STEM Alignment and Diversity

Name of Committee:	STEM Engagement Committee
Chair of Committee:	Dr. Aimee Kennedy <i>(presented by Mr. Daniel Dumbacher)</i>
Date of Council Public Deliberation:	November 1, 2019
Short Title of Finding:	STEM Alignment and Diversity

Finding: The STEM Engagement Committee applauds the effort to develop the direct correlation of the Office of STEM Engagement (OSTEM) objectives to the Federal 5-Year STEM Strategic Plan. This effort leads to an architecture enabling student opportunities in STEM activities based on the results from the Spark study. As OSTEM proceeds with the ongoing planning effort, the Committee would like the opportunity to review the resulting relationship of OSTEM activities to the overall Federal plan, and asks that OSTEM provide direct evidence demonstrating the direct support of Federal 5-Year STEM Strategic Plan. The Committee supports OSTEM's plan to provide evidence of utilizing intentional activities and methods for assuring STEM activities reach the diverse, under-served and under-represented communities. The Committee also feels that metrics would be valuable to measure the results for reaching out to new communities.