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Statement of
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before the

Subcommittee on Space and Aeronautics
Committee on Science and Technology
United States House of Representatives

Chairwoman Giffords and Members of the Subcommittee, thank you for the opportunity to appear before you today to discuss the top priorities and challenges facing NASA, the corresponding decisions that are required, and the Agency's ability to address these issues within the context of the budgetary outlook described by its 2010 request.

The NASA Advisory Council (NAC) was also asked to discuss the corrective actions NASA has taken to implement a solid financial management foundation and merit an improved audit opinion. The NAC, through our Audit and Finance Committee under the leadership of Mr. Robert Hanisee, has worked closely with NASA on these areas. Mr. Hanisee will provide you with a comprehensive account of the progress that has been made and the issues remaining. We are pleased with the tremendous improvements that NASA has made in its financial management.

Next month we will celebrate the 40th anniversary of the first human footprint on a world other than our own. This is a time for our Nation to both look back with pride in our accomplishments and to look forward with great expectations for the next 40 years in space. It is also time to re-commit ourselves to taking those next steps.

I will identify what I believe to be a few of the highest priorities for your consideration during this potentially pivotal moment in our Nation's space program. Choices and decisions will be made that will determine what we can and cannot accomplish in space for the next 40 years.

Flying the Shuttle Safely

NASA has developed a prudent and technically rigorous approach to Shuttle operations. Human spaceflight remains one of the hardest things humans do. When the inevitable technical problems have arisen, NASA has consistently demonstrated the commitment to take whatever time necessary to resolve the problem before proceeding in a safe, deliberate manner. The challenge will be to maintain this level of vigilance through the remaining seven flights of the Space Shuttle program. Commendably, Congress and the Administration have laid the foundation by directing NASA to focus on completing the

remaining Space Shuttle flights, rather than forcing the Agency to finish the Shuttle flights by an arbitrary deadline. The Congress and Administration must be prepared to act on this direction by providing additional funding in the case that the flights need to be delayed. This strategy eliminates the perception of schedule pressure that may cloud safety and technical decision making. It is equally important that NASA retains the critical workforce skills and facilities that are needed to ensure the safe completion of the Shuttle program. Congress and the Agency can help provide a sense that the work that the Agency is doing in space is recognized as being necessary and important to the country. This is accomplished by providing stable funding and an unwavering vision for the future. Such an approach will significantly help with workforce retention. In summary, while NASA's current plans to complete the final seven flights of the Space Shuttle program by the end of 2010 are indeed ambitious, the Agency has the mechanisms in place to safely complete the shuttle missions. NASA must, however, remain vigilant, taking one mission at a time, doing it right, and doing it safely.

Develop a Capable and Flexible Space Transportation Architecture

In the aftermath of the loss of Space Shuttle *Columbia*, Admiral Hal Gehman, Chairman of the *Columbia* Accident Investigation Board, released a remarkable report that pointed to the fact that NASA had operated for more than three decades in the absence of a guiding vision for human spaceflight as a root cause of the *Columbia* accident. In response, a thoughtful and logical civil space policy was put forth. After extensive and healthy debate, a Republican Congress approved this policy as the guiding strategy for NASA, and three years later a Democratic Congress did likewise. Both presidential candidates in 2008 issued specific statements supporting a strong human space program, and President Obama's first budget request calls for lunar return by 2020. Thus, in the last five years two presidents and two Congresses, each of opposite parties, have affirmed the United States Vision for Space Exploration.

It is NASA's responsibility to implement the vision within the resources provided by Congress. It is very likely that the space transportation system now under development will need to serve the nation for the next 30-50 years. We need to get it right. This will be the basic spaceflight architecture that takes Americans beyond low Earth orbit (LEO), back to the Moon, to Near Earth Objects and on to Mars.

The key element in the exploration architecture is the development of a heavy lift launch vehicle. I urge Congress to accelerate and prioritize development of this capability as it is the key to everything we will do in human spaceflight beyond LEO. Accelerated development of a heavy lift launch vehicle can also help with retaining a skilled workforce both in production and the processing that takes place at Kennedy Space Center. The plan has been to apply the work force coming off Shuttle to development of the Shuttle-derived heavy lift Ares-V. With the budget that would have funded early lunar work now eliminated, the work force transition is further at risk. For the Ares-V concept, the 5-segment solid rocket booster and J2X upper stage engine are already in development. The first 5-segment booster test firing is planned for August of this year. The J2X engine passed its critical design review last fall. Although many technical challenges lie ahead, substantial progress *has* been made.

As noted above, a heavy lift capability is mandatory for journeys beyond LEO. The Ares-V and Orion are sized for missions to Mars. The crew of 6 and Ares-V lift capabilities were originally derived from Mars mission studies. These capabilities encompass all other human missions that are feasible at this time, including the Moon, asteroids, LaGrange points, and near Earth objects.

Building a heavy lift launch capability and doing so on an aggressive schedule is the right thing because not only does it provide the ability to go beyond LEO, but it also enables a stepwise and evolutionary building block to progressively longer and more demanding science and exploration missions to explore the Moon, Mars, and other locations. Making this choice and stepping up to it now is a wise investment in our future that will undoubtedly yield untold benefits.

Assuming that the International Space Station (ISS) is to be extended beyond 2015, serious thought must be given to the means of support for both cargo and crew. The current Space Transportation Architecture is intended to provide Government-furnished crew access to the ISS. As NASA has clearly stated from the outset, if commercial crew access materializes, NASA will utilize that service. Although commercial cargo transport may be available sooner, it seems unlikely that commercial crew transport to ISS will be available before 2015 or 2016 — and even then only with a substantial infusion of additional Government funding. That said, unless the Constellation Program is funded at or above the 2010 budget request, it seems equally unlikely that Ares-I will be available before 2016 or perhaps even early 2017. Continued schedule slippage could leave the ISS without a U.S.-provided crew transportation capability for an extended period of time. If Ares-I/Orion significantly slips schedule, the argument for their necessity weakens dramatically. In fact, the latest House markup would likely further increase the gap in U.S. Government-provided access to space to the point where Ares-I support of ISS may become irrelevant unless ISS operation is extended well beyond 2015.

There are, of course, other options for access to ISS. These options will have budget impacts and may not be executable in time to support ISS. The aforementioned options could include increased reliance on international partners (*Soyuz)*, more Shuttle flights, a smaller capsule on a human-rated EELV, an Orion capsule on a human-rated heavy lift launch vehicle — or some combination of the above. There are significant challenges and difficulties associated with each of these approaches. We, as a Nation, need to confirm our strategy and then let NASA implement it with adequate and stable resources.

When a program such as Constellation has to re-plan, due to significant budget cuts, it means that schedules are shifted and contracts must be changed and renegotiated to a new baseline, inevitably at higher cost. The schedule delays also impact the ability to retain the highly skilled workforce currently working in support of the Shuttle and ISS systems. As the schedule slips, workers are first impacted in the hardware manufacturing facilities, and then as launch and orbit operations are delayed, workers are impacted in launch processing and operations. These workers have unique skills, and it is important to retain much of this workforce for the new systems. This unstable funding scenario is reminiscent of the instability in the Space Station Freedom yearly budgets in the late 80's

and early 90's that resulted in annual re-planning, cost overruns, and delays. Large-scale engineering development programs and the associated contracts cannot be stopped and started without the inefficiency of re-planning, loss of critical skills, additional significant costs, and loss of schedule. I hope that this is a "lesson learned," and that it will not have to be *relearned* at great cost. The current budget environment is jeopardizing the future of U.S. human spaceflight at a time when NASA has made significant progress toward development of the new Space Transportation Architecture.

On October 16, 2008 the NAC Exploration Committee offered the following formal observation following their careful evaluation of progress on the Ares Launch Vehicle,

> *"Given the quality of NASA's analysis and the project's momentum, it is imperative to maintain stability and continuing progress on execution of the current plan. The Ares project is well underway with an established baseline and provides a solid foundation for the Constellation Program. The current Exploration Program has strong and accelerating international support and participation. "*

The NAC Exploration Committee will continue to monitor progress toward development of the Space Transportation Architecture that will serve this Nation for decades to come and make recommendations as merited.

Need for a Decision Regarding International Space Station (ISS)

I believe the International Space Station (ISS) to be among the most ambitious engineering projects ever undertaken by humanity. It's larger than a football field, weighs nearly a million pounds, and is gracefully orbiting our planet at 7.7 kilometers per second. Perhaps equally impressive has been the fifteen-nation partnership that designed, built, and operates the ISS.

When it is finished, the ISS will be a laboratory unique in human experience. Already, preliminary results look promising for progress toward development of new vaccines and therapeutic drugs against salmonella and MRSA. But more importantly, it affords an opportunity for humans to learn to live and work in space for long durations. This knowledge will be of great value when we are ready to send humans to the Moon and eventually Mars. The lessons of long-duration spaceflight are better learned when you are only hours away from the safety of Earth, and not days away when on the Moon, or months away when traveling to Mars.

Currently, there is no consistent direction for ISS utilization past 2015 other than to take no action to preclude its continued operation. A timely decision regarding the future of ISS is needed. Uncertainty of purpose and plan is damaging for science utilization, negotiation with our international partners, and development of a stable commercial cargo market.

Space Station has cost us much in treasure ($50+ billion) and in human life, but now it is nearly finished. It would seem imprudent to have spent the last 25 years building this remarkable facility only to abandon it shortly after completion.

Reestablish a Robust Technology R&D Program at NASA

NASA has long enjoyed a reputation as a technology innovator whose stressing applications in space and aeronautics have led to an incredible range of broadly useful technologies. Several years ago, the decision was made to divert a large fraction of the Agency's technology investment into the Constellation Program with the goal of maintaining an early initial operational capability. As a result, NASA no longer enjoys the benefits of a strong technology program and is very limited in its ability to seek new ideas both internal and external.

Unfortunately, technology research programs are easily stopped and terribly hard to restart. In a time of constrained budgets, it will take strong and effective leadership at the Agency and by Congress to reestablish NASA as a technology leader. The moral of this story is that viable and productive research programs require stability.

A robust and useful technology program at NASA would be dedicated to stimulating innovation and developing new capabilities not tied to existing mission requirements. There are many negative consequences associated with the loss of a technology research program, but one of them is that missions, such as NASA's science missions, must carry all the technology risk in the mission itself. Additionally, in the human-spaceflight side of the house, the lack of a robust technology program has naturally driven program managers toward relatively conservative and often low-tech designs.

A large part of the public's strong support for NASA derives from the once accurate perception that NASA is a driver of innovation and technology. The NASA Advisory Council is in the process of examining NASA's current technology programs in terms of quality, scope, and adequacy — and will make a recommendation as appropriate.

On the Need for Stability

Space Exploration is an inherently challenging and rewarding endeavor — it takes courage, calculations, capital, choreography, and consistency. Stability in planning, requirements, budgets, and programmatic execution are essential for successful mission accomplishment.

The current U.S. Space Policy is the best one we have had for a very long time: it meets existing commitments, and then puts NASA on a new path in an orderly, disciplined, manner. The policy strategy was strongly supported by both the 2005 and 2008 NASA Authorization Acts in both Republican and Democratic Congresses. It is NASA's job to implement that policy.

In my view, the most important factor in NASA's future success will be stability in purpose, strategy, requirements, and funding. If our Nation's leadership cannot provide that stability, NASA's efforts to implement the nation's space policy will cost more and accomplish less.

NAC assessment of NASA responses to NAC recommendations on (a) human capital and (b) science mission cost drivers:

Infusing new talent and knowledge into the NASA workforce

The NAC believes that continued leadership in aeronautics, space science, and exploration requires the constant infusion of new ideas and state-of-the-art technological knowledge provided by a vibrant and creative workforce. As a result of very limited hiring at NASA over the past 15 years, a large proportion of the new hires were those with a higher level of experience and expertise. As a consequence, NASA's current workforce consists primarily of mid-level and senior-level professional scientists and engineers. Therefore, to ensure that NASA has the talent needed to support current and future space and aeronautics missions, the NAC has recommended that NASA focus on hiring "fresh-out" talent, which is defined as individuals who have obtained a degree within the past three years.

NASA has already begun taking steps to address the issue raised by the NAC. NASA has secured support from the Office of Science and Technology Policy (OSTP) to pursue increased hiring specifically for the purpose of enhancing the workforce pipeline. As a result of this support, NASA has made two substantive and strategic hiring commitments to infuse new entry-level talent and knowledge into its workforce. First, NASA has initiated a pilot program designed to target approximately 200 additional hires in FY09 as a near-term infusion of entry-level talent. To implement this program, the Office of Human Capital Management is partnering with the Mission Directorates, the Office of Diversity and Equal Opportunity, and the Office of Education to provide guidance and direction to the Centers on a strategic hiring plan that targets recruitment efforts that are consistent with merit system principles. Second, NASA has committed to using a higher proportion of its annual hiring opportunities created through natural attrition on entry-level hires. The Centers have already been directed to replenish losses with a higher number of entry-level hires.

The tasks we ask NASA to accomplish on behalf of the Nation are some of the hardest things humans do. Thus, while the NAC is pleased with NASA’s efforts to balance its workforce, we hope that it will make every effort to recruit the very best talent to the Agency. Our Nation’s continued leadership in Space and Aeronautics will depend on NASA’s ability to hire the “best and the brightest”.

Communicating lessons learned on large cost drivers in science missions to inform the next round of decadal surveys

In general, NASA does a good job of estimating prices, as well as managing schedules and costs for small (e.g., Explorer-class) and medium size science missions. In these cases, the science scope and new technology development are relatively modest, and so costs and risks are better understood. In recent years, the problems with under-costing and maintaining schedule have nearly all arisen from flagship class missions. For these large science platforms, the required technology advances have been very significant in order to meet bold new science goals. Thus, it is not surprising for these one-of-a-kind missions that costs or schedules are sometimes exceeded because extrapolation from

existing models is an inadequate predictor. This is NASA's dilemma for large science missions and parallels problems experienced by other Federal agencies (e.g., NOAA, DoD space missions, and even recent NSF large ground-based projects). Solutions to the cost estimation and cost containment problems for large, unique missions are among NASA's (and all Federal agencies) greatest challenges. Maintaining realistic yet ambitious science goals, leading to more incremental new technology requirements, coupled with larger upfront mission reserves are likely to be elements needed for successful large space science missions for the future.

The NAC Science Committee has played an active role in monitoring, reviewing, and suggesting changes regarding the management of costs for science missions. The Committee reviews the status and expenditures of NASA's major science missions (e.g., JWST, JDEM, MSL, MMS) quarterly at each of its meetings. NASA managers present updates on technology, engineering, and science goals for science missions to discipline subcommittees who review, comment, and make recommendations to the NAC Science Committee. The NAC compares previous expectations on design and construction along with expenditures for major missions to the actual progress in each quarter. Technical and budget problems are probed, explanations are sought, and solutions are then reviewed by the NAC who advise the Administrator on emerging mission issues.

Recently, the NAC recommended that NASA compile lessons learned on the costing of science missions. The NAC believes the NRC decadal survey committees need to understand how early choices in mission concept design lead to cost growth so they can structure their recommendations to be more robust over time. Therefore, the NAC recommended that NASA compile lessons learned on pre-phase B cost estimation for large missions, including influence of interactions among the science community, the NRC, NASA Headquarters, and Centers. Additionally, NASA was asked to provide an initial product to the NAC Science Committee at its July 2009 meeting prior to provision to the NRC committees initiating their new round of decadal surveys in the space sciences.

The NRC decadal surveys establish community and stakeholder expectations for science missions to be developed and launched in the coming decade or beyond. Mission concepts are generally ranked in priority order by cost class. In the last round of NRC decadal surveys, some high priority mission(s) ranked on the basis of an initial cost estimate turned out to be two to four times as expensive to develop. This leads to questions of whether those same rankings would have been assigned had more realistic cost estimates been available, and whether some different mix of missions might have been recommended to achieve the optimal science return within available funding constraints. Thus, the current astronomy and astrophysics, and planetary science decadal surveys are contracting for independent cost estimates for proposed new missions.

NASA's response to the NAC recommendation noted that the Congress, in the 2008 NASA Authorization Act, had a similar concern and required NASA to arrange for "an independent external assessment to identify the primary causes of cost growth." To

comply, NASA contracted with the National Research Council of the National Academies to conduct this study. The study will:

- Review the body of existing studies related to NASA space and Earth science missions and identify their key causes of cost growth and strategies for mitigating cost growth;
- Assess whether those key causes remain applicable in the current environment and identify any new major causes; and
- Evaluate effectiveness of current and planned NASA cost growth mitigation strategies and, as appropriate, recommend new strategies to ensure better cost containment and success of future missions.

NASA intends for this study to achieve the NAC recommendation. NASA's view is that tasking the NRC to do this study should facilitate the use of its results by the decadal survey committees, which are also NRC entities. The results of this study will be timely for the planetary sciences decadal survey but may not be available in time to impact the astronomy and astrophysics survey.

The NRC "lessons learned" study along with the Decadal Surveys must wrestle with the trade-offs between ambitious science goals, new technology requirements, and costs. The NAC will continue to be vigilant in working with NASA to continuously review each flagship science mission and to apply the lessons learned from the upcoming NRC study.

Conclusion

My letter of invitation asked me what were the most important issues and decisions that must be made regarding NASA. You will notice that I did not talk much about the Space Science or Aeronautics Mission Directorates. This is not because they are unimportant: to the contrary, they are *very* important, but they are each on paths going forward that seem more clear and less full of doubt than the path for human spaceflight.

In most days, there is very little among the thousands of items filling the 24-hour news cycle that will be regarded as important and noteworthy in 500 years. However, the accomplishments of this Agency of the U.S. Government are among the few human activities that will be looked upon with admiration and, if humans are still capable of the emotion, with awe. They will marvel at the courage, curiosity, and audacity of a people who put the first human foot print on a planet other than their own, who sent their robotic ambassadors deep into the solar system…not to conquer…or for financial gain…but just to know. They will wonder if they could measure up to such people.

I look back at the Apollo era and wonder the same thing…and hope that our generation will also be included as worthy of their admiration. We will not have to wait 500 years to know the answer.

I would be happy to respond to any questions you or the other Members of the Subcommittee may have.