

**TRANSITIONING TO A NEXT GENERATION
HUMAN SPACE FLIGHT SYSTEM**

HEARING

BEFORE THE

SUBCOMMITTEE ON SPACE, AERONAUTICS, AND
RELATED SCIENCES

OF THE

COMMITTEE ON COMMERCE,
SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

March 28, 2007

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ONE HUNDRED TENTH CONGRESS

FIRST SESSION

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CONTENTS

Hearing held on March 28, 2007	Page 1
Statement of Senator Nelson	1

WITNESSES

Dittimore, Ronald D., President, ATK Launch Systems Group	22
Prepared statement	22
Gerstenmaier, William H., Associate Administrator, Space Operations, NASA	2
Prepared statement	2
Horowitz, Scott J., Associate Administrator, Exploration Systems, NASA	38
Karas, John C., Vice President and General Manager, Human Spaceflight, Lockheed Martin Space Systems Company	10
Prepared statement	10
Li, Allen, Director, Acquisition and Sourcing Management, GAO	13
Prepared statement	14
McCulley, Michael J., President and CEO, United Space Alliance	6
Prepared statement	6
Walker, Johnny, Directing Business Representative, District Lodge 166, Inter- national Association of Machinists and Aerospace Workers	23
Prepared statement	24

APPENDIX

Hutchison, Kay Bailey, U.S. Senator from Texas, prepared statement	41
Response to written questions submitted by Hon. Kay Bailey Hutchison to: Ronald D. Dittimore	49
William H. Gerstenmaier	43
John C. Karas	47
Allen Li	50
Johnny Walker	49
Response to written questions submitted by Hon. Daniel K. Inouye to William H. Gerstenmaier	41
Response to written questions submitted by Hon. Bill Nelson to: William H. Gerstenmaier	42
Johnny Walker	48
Response to written questions submitted by Hon. Mark Pryor to: William H. Gerstenmaier	46
John C. Karas	47

TRANSITIONING TO A NEXT GENERATION HUMAN SPACE FLIGHT PROGRAM

WEDNESDAY, MARCH 28, 2007

U.S. SENATE,
SUBCOMMITTEE ON SPACE, AERONAUTICS, AND RELATED
SCIENCES,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:30 p.m., in room SR-253, Russell Senate Office Building, Hon. Bill Nelson, Chairman of the Subcommittee, presiding.

OPENING STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM FLORIDA

Senator BILL NELSON. Good afternoon. Thank you all for being here. Thanks for all the interest, as evidenced by everybody here in the hearing room today. We are going to have to be a little flexible today, because they have called a series of four votes, starting in just a couple of minutes.

I will try to keep us going as much as possible, with Senator Hutchison coming back over. What we want to do is, to really get some quality time talking to you.

Instead of the typical way, where you read a statement—we are not going to do that. We are going to take your written statements and put them in the record.

And save for the interruption that we are going to have with the votes, what I want to do is just to have a conversation with you about—the subject before us. And that is the space program, and what we have to do to keep this gallant little program that has been such an inspiration to the American people on course, as we shift into a whole new arena, with a new set of spacecraft, and as we continue the construction of the International Space Station. As we try to minimize the gap in human spaceflight, from when we shut down the Space Shuttle, to when we start flying humans on the new vehicle. And how do we do that?

If we are not launching humans, how do we do that and keep that Space Station going up there as a laboratory. What are going to be the geo-politics in 2015? Are the Russians still going to be allied with us in 2015? I do not know the answer to that. I hope so. But there is no certainty for that.

These are the kinds of things that we have to talk about. We have a star-studded cast here today. Mr. Gerstenmaier, NASA Associate Administrator for Space Operations; Mr. Li, GAO Acquisition and Sourcing Management; Michael McCulley, Chief Executive

Officer of United Space Alliance; John Karas, Vice President, Space Exploration, from Lockheed Martin; Ron Dittmore, President of ATK; and Johnny Walker, the International Association of Machinists and Aerospace Workers.

Well, sure enough, they just called the vote. Why don't you go in no particular order, start to offer some of your thoughts on this.

[Laughter.]

Senator BILL NELSON. Mr. Gerstenmaier.

**STATEMENT OF WILLIAM H. GERSTENMAIER,
ASSOCIATE ADMINISTRATOR, SPACE OPERATIONS,
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

Mr. GERSTENMAIER. OK. I guess I will start a little bit. I think this is a tremendously challenging time, as you laid out. And I think the challenge in front of us is how to fly the Shuttle safely for the remaining flights, through assembly of the Space Station, to get the Space Station built, so we have a national laboratory and research facility to go use. That is a tremendous challenge in itself, to get that activity done. And then at the same time, we need to start preparing and start bringing online the Constellation systems. We have started a lot of that work already. We have transferred a test stand at Stennis over to the new program, to begin engine testing on their side.

The firing room down in Florida. Firing room one has been transferred over to exploration, to begin preparations for their test flight in 2009. The Operations and Checkout Building down in Florida has already been transitioned. So I think we have been making pretty good progress overall. We recognize that there is a lot of work in front of us. A lot of challenges. Many of the questions that you brought up in your opening statements we will address later, as we go through. But, again, I think we have the right workforce to go do this.

We have the right contractor–NASA team that is working this as a team, figuring out a way to make this go work. And we have as good a plan as we can have at this point to go forward, with plenty of challenges in front of us.

[The prepared statement of Mr. Gerstenmaier follows:]

PREPARED STATEMENT OF WILLIAM H. GERSTENMAIER, ASSOCIATE ADMINISTRATOR,
SPACE OPERATIONS, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Chairman and members of the Subcommittee, thank you for the opportunity to appear before you today to discuss NASA's efforts as we prepare for the Space Shuttle's retirement and work to develop the new human space exploration vehicles. This "transition" provides us with a unique opportunity to reinvent and revitalize NASA's human spaceflight program and make it more efficient by focusing on the evolution of our skilled workers and our facilities and infrastructure. Never in the almost 50-year history of the agency has a task of this magnitude been undertaken. The kind of sweeping changes that this transition will bring can be daunting. But what I tell my workforce, and what I truly believe, is this: "We are not going out of business; we are starting a new business." We have the unique opportunity to be performing the most complicated space assembly activities ever attempted, preparing the International Space Station (ISS) to become a National Laboratory, and developing the systems that will be used for human exploration of the solar system. These activities will require us all to work together and provide leadership and focus, as many activities compete with each other for time and resources. Performing these activities successfully will inspire the next generation and maintain our world leadership role in space. This is a great time to be in the space business.

For the next 4 years, NASA's top priority is to safely fly the remaining Shuttle flights to complete assembly of the International Space Station (ISS). At the same time, the agency is preparing to bring the new U.S. human spaceflight capabilities on-line soon thereafter. With the retirement of the Shuttle in 2010, NASA will fundamentally shift from the current primary focus on operations to one in which we develop new systems, conduct research on the ISS, and re-establish the capability for space exploration missions beyond low Earth orbit, with the ultimate goal of returning to the Moon, going to Mars and beyond. These are significant challenges, and we need help from Congress to succeed, specifically by supporting the Vision for Space Exploration, approving the President's FY 2008 budget for NASA at the requested levels and approving the workforce transition and facilities management tools in the legislative proposal that NASA recently submitted to Congress. I appreciate the leadership of this subcommittee and the Congress in enacting the NASA Authorization Act of 2005 (P.L. 109-155); this legislation is a good example of the support that you have already provided.

An effective transition of workforce, facilities, and contractor support from the Space Shuttle program to the new Constellation program will be jeopardized by a prolonged gap between Shuttle operations and the Initial Operating Capability of Orion and Ares, such as the gap which developed between the Apollo-Soyuz program and the maiden flight of the Space Shuttle. Our job as a leadership team is to actively manage the gap, ensure that our workforce skills are rebalanced to meet the evolved focus of the agency, and effectively communicate our actions and goals to all of our stakeholders, most importantly our employees.

Funding limitations and hardware development lead times will not allow us to overlap Shuttle and Constellation capabilities. We know there will be a gap—our job is to keep this gap to a minimum, and with your help, this can be accomplished. I am often asked why NASA does not just extend the Shuttle program to close the gap. The primary reason I give is that the high fixed costs of the Shuttle program do not allow that strategy to work. Extending the Shuttle program a year would cost approximately \$3-4 billion per year. These funds would come from Constellation development and, consequently, would only extend the gap. Another reason is that the Shuttle is an extremely complicated vehicle to operate. Many systems interact with others. Consider the interaction of foam from the tank on the Shuttle as an example. Safely operating this complex vehicle is not easy. NASA has chosen to use the Shuttle with this safety complexity for only those missions requiring the Shuttle's unique capabilities. The assembly of the ISS, Hubble Space Telescope servicing mission, and ISS spares carried on the logistics flights all require the unique capability of the Shuttle. Once these missions are complete, NASA needs to transition to the simpler and safer Orion Crew Exploration Vehicle (CEV) as soon as feasible. We believe that human spaceflight is a strategic capability for this Nation, and we recognize the important role NASA plays in ensuring the U.S. maintains this capability.

Transition starts with phasing out the Space Shuttle and bringing CEV online, continues with the research and testing that will take place on the ISS as part of a National Laboratory, and includes using the Commercial Orbital Transportation Services (COTS) program to demonstrate new capabilities for re-supply. As the Shuttle approaches its retirement, the ISS Program intends to use alternative cargo and crew transportation services from commercial industry. Once a capability is demonstrated in Phase 1 of the Commercial Orbital Transportation Services (COTS) Space Act Agreements, NASA plans to purchase cargo delivery services competitively in Phase 2 and will decide whether to pursue crew demonstrations. NASA will be in an almost continual state of transition as development of one phase of exploration transitions from development to operations. Consequently, what we are establishing now is a transition framework that will serve us through the decades ahead. NASA chose not to create a separate program to manage transition, but instead utilize organizational elements within the existing operating program and the future exploration program. This structure ties transition directly to the safe operation of our programs and allows for a framework for transition to be established within NASA.

The goal of transition is to keep the U.S. space workforce fully engaged and moving toward design and development of the new vehicles. Our focus is on life-cycle cost and risk management of our workforce, infrastructure, and facilities, including the necessary budget and plans to execute the ambitious agenda at hand. Full funding of NASA's FY 2008 budget request is critical to ensuring the gap between retirement of the Space Shuttle and America's new human spaceflight capability does not grow longer. If the gap in our human spaceflight capability extends even further than already planned, I believe our Nation may be ceding leadership in human

spaceflight at a time when other nations are outlining ambitious programs of their own.

NASA's transition planning activities emphasize three major themes: 1) safely flying out the Shuttle manifest; 2) closing out and streamlining our facilities and infrastructure; and 3) reorienting our workforce for future missions. We are heading in the right direction and have a robust plan in place with the right people to execute it. We have made great strides this past year and will maintain this momentum as we continue to make substantial and rapid progress in carrying out the challenging space operations and transition tasks ahead.

1. Safely Flying Out the Shuttle Manifest

While we look toward the future, we know we cannot lose sight of the present. NASA is committed to safely flying the Shuttle through its retirement in 2010 to complete construction of the ISS, which will fulfill our commitments to our International Partners and enable us to conduct exploration-focused research onboard. While there are challenges ahead, we have a good, sound plan that places safety above all else. As evidenced by the recent hail storm that caused damage to the STS-117 External Tank, that plan may not go exactly the way we have laid out, but we are prepared to continue working through it and to adjust as needed. We will learn from these challenges and gain experience necessary for future ventures to the Moon and Mars.

The Shuttle manifest calls for 13 assembly flights to the ISS, one to service the Hubble Space Telescope. In addition, we could potentially add 2 ISS logistics flights to the manifest if they are needed and can be flown safely before the Shuttle's 2010 retirement. In order to safely complete these missions, retention of our workforce, with their skills and tremendous dedication, is critical. A recent survey of Shuttle personnel across the NASA field centers clearly demonstrates that we have highly-motivated people who want to stay for the remainder of the program and see it succeed. As an Agency, we share their pride in the program's accomplishments and are heartened by their commitment to safety and mission success. As leaders we contribute to this success by showing through our actions a strong commitment to these activities, as well as the promise of exciting future endeavors.

2. Infrastructure and Facilities

The Shuttle program currently occupies over 600 facilities at both government and contractor sites and has more than 900,000 pieces of equipment. The estimated new acquisition value of these assets is approximately \$12 billion for equipment and approximately \$5.7 billion for facilities. This is a vast amount of resources that the American people have invested in and entrusted us with. We are committed to leveraging this investment by utilizing Shuttle infrastructure wherever it makes sense in the Constellation programs. We have already made progress in this respect. At NASA's Kennedy Space Center in Florida, the Space Shuttle program has transitioned Firing Room 1 and the Operations and Checkout Building to Constellation. Work is also underway to transition Launch Complex 39B to eventually launch Ares and Orion. At Stennis Space Center in Mississippi, the A1 Rocket Test Stand, formerly used to test the Space Shuttle Main Engine, is now testing engines for Constellation. And at Johnson Space Center, key leaders in the ISS program have transitioned to senior management positions in Exploration, bringing with them their technical and programmatic expertise.

Since our new spacecraft designs are Shuttle-derived, we can build on the existing infrastructure across the agency. However, many of our key facilities and infrastructure elements are almost 50 years old in areas prone to aggressive climate impacts and heavy operational demands. As the transition to the next U.S. human spaceflight capability progresses, we have the opportunity to streamline all aspects of our business and provide more value to the American people. We also are assessing our infrastructure to ensure that we have the necessary foundation for the next 30 years of exploration activities.

3. Workforce

Guiding the agency's transition is the recognition of the critical role played by our approximately 17,000-strong workforce. As the Associate Administrator for Exploration Systems Scott Horowitz likes to say, "When folks ask me how we go into space, they expect me to say 'Rockets and hardware,' but I think people make the Space Shuttle fly not hardware." The men and women who work in the Space Shuttle program are some of the Nation's most skilled, efficient, and committed workers—qualities that the agency and Nation needs for its future missions and must capitalize upon.

As mentioned earlier, the nature of the work these employees will do will change as we transition from Shuttle operations to research and development-focused ac-

tivities like planning, design, testing and verification for Constellation systems. We are striving to give our employees opportunities to build on their existing skills by working on the new exploration systems, so that when this development work comes on-line, they can easily transition into new positions. Coupled with newly gained skills, our workforce can take the skills honed in Shuttle operations and apply them to the design of the next vehicle to make it fly more efficiently. Preventing a prolonged gap between the last Shuttle flight and the first Orion flight remains the single most important factor in workforce transition. The longer the gap, the more difficult it becomes to retain our needed workforce.

As the Constellation System Requirements Reviews are completed this year, NASA will gain a much clearer understanding of the demands for future workforce skills, which will form the foundation for making any future decisions. Although we are proud of recent progress, we acknowledge that more needs to be accomplished. These tasks include matching available skills with future work, managing attrition, retraining and hiring, and using temporary and term appointments to get the flexibility to align our needs with our time-phased workload.

NASA remains committed to working with our industry, supplier, and research partners to craft and implement strategies to minimize disruption, upheaval, and economic impact, while maximizing support vital for Shuttle missions and program requirements. As we move forward, we know that clear communication and solid leadership will be key to our success. I cannot stress one point enough—NASA recognizes and values the dedication of its Shuttle workforce. The Agency in return is dedicated to ensuring that those men and women have challenging future work that capitalizes on their unique skills and abilities. Make no mistake there will be changes for our workforce, but if we provide leadership and focus, I am confident that this team will respond. They have overcome difficult challenges in the past: Katrina, hail storms, and the *Columbia* disaster. If we can give them a vision of the future, they will help us to realize that future. This is the best workforce in the world.

Conclusion

NASA has many transition challenges ahead of us, but we are on track and making substantial progress in managing a fundamental shift from operating spacecraft in orbit around the Earth to cutting-edge research and development for space exploration that will push humanity out of low-Earth orbit and across the solar system. This is an exciting time for NASA and the Nation.

We need your continued support to accomplish this endeavor and to ensure that the United States maintains its status as the world leader in human space exploration. Thank you for the opportunity to discuss this important effort, and I would be pleased to respond to any questions that you may have.

Senator BILL NELSON. Dr. Griffin told me that he felt like that in order to get the gap, that is now up to 2015, with the funding profile that there is now, back to 2013, a 3-year gap. He would need an additional \$400 million over and above the President's request in 2008 and an additional \$600 million in 2009 and 2010 over and above what is the expected President's request. Tell me what you think.

Mr. GERSTENMAIER. Again, I think we would really like to take that for the record and go put some analysis behind that, and see how it really fits. I think conceptually those are the right numbers. But there are lots of details that go behind that. Even though the funding may be there, there may be critical components on the critical path that we just cannot get completed in time to make those schedules. So I think we need a little bit of time to go sort through all that and see how all that fits. And then see if it fits financially as well as if it fits technically in that period that you just described.

Senator BILL NELSON. It was \$800 million in Fiscal Year 2009 and another \$800 million, Fiscal Year 2010. Instead of \$600 million. So the White House could help us, if they would request the increase instead of their increases coming way underneath what the authorization bill calls for. But it is what it is. And we are

where we are. So either we are going to give you all the resources with which to be able to narrow to a 3-year gap. Or it is going to be a 5-year gap.

Mr. McCulley, what would be some of the consequences of a 5-year gap down at the Cape?

**STATEMENT OF MICHAEL J. McCULLEY, PRESIDENT AND CEO,
UNITED SPACE ALLIANCE**

Mr. McCULLEY. A tremendous loss of a critical national resource in the workforce. Not in numbers so much as it is in the skill sets that exist there. As you well know, and certainly everybody on this panel knows, we are primarily ops. Not development. Not design. Not manufacturing. And the skill set is a unique skill set, whether it is in Houston or whether it is in Florida, whether it is rendezvous and proximity operations, or whether it is process and flight hardware, and payloads, and the pads, and all those things.

An extended gap just makes it a larger problem for us to figure out how to keep the skill set that the Nation needs to operate the next vehicle.

[The prepared statement of Mr. McCulley follows:]

PREPARED STATEMENT OF MICHAEL J. McCulley, President and CEO,
United Space Alliance

Chairman Nelson, Senator Hutchison, members of the Subcommittee, thank you for providing me the opportunity to discuss the transition from the Space Shuttle to the Constellation programs now underway in America's human spaceflight program.

On behalf of the 10,000 employees of United Space Alliance and our 5,000 supplier employees across the Nation, I thank you for caring about the future of these highly skilled workers and valuing the human spaceflight community's contribution to the economic security of our Nation.

Congress has always recognized the importance of investing in NASA and its crucial role in advancing the Nation's scientific, economic and security interests, as well as fostering the next generation of America's scientists and engineers. NASA's benefits go well beyond just the acquisition of space goods and services. NASA and its industry partners develop critical technologies that broadly benefit our society, spur the development and advancement of competitive industries, and encourage young people to study disciplines that will enable them to successfully enter the modern global economic workforce. According to the Aerospace Industries Association, in 2006 U.S. aerospace industry revenues topped \$184 billion. Due to its international competitiveness, our industry is one of the few that carries a trade surplus—\$52 billion last year. The level of exports by our aerospace industry is almost three times the level of imports.

The transition from Shuttle to Constellation will have a ripple effect throughout our industry and our national economy. The question is whether that effect will be positive.

As NASA Administrator, Mike Griffin, has testified, the transition will be a challenging and multi-tiered process that will touch every aspect of human spaceflight operations. NASA is expected to finish construction of the International Space Station by safely flying the Shuttle while also bringing online the most diverse mix of space vehicles to be developed, maintained and flown in more than a generation: the Orion Crew Capsule, the Shuttle-derived Ares I Crew Launch Vehicle (CLV), a Heavy Lift Cargo Launch Vehicle (CaLV) known as Ares V, the Lunar Lander, and other vehicles with varied cargo and payload capabilities.

As you know, USA does not determine the budget or policy for the NASA human spaceflight program, but rather, we implement in support of our NASA customer. That said, I have been asked to comment on the transition from current Shuttle operations to the next generation of spaceflight vehicles.

"The Gap"

As currently defined, there will be a four or five-year gap between the final Space Shuttle flight in September 2010, and the first planned Ares I crew launch. During

“the gap,” the United States, the recognized leader in space exploration and human spaceflight, will be dependent on Russia, ESA, Japan and the now-developmental COTS vehicles for human and logistics transportation to the ISS and will be buying services using U.S. taxpayer dollars.

I know that members of this committee and other Members of Congress recognize that a lengthy gap will jeopardize our global leadership in space and are seeking ways to make “the gap” as short as possible. Russia, China, India, Japan, and European nations are investing in human space exploration. In order to maintain our leadership, Americans must work together to shorten “the gap” to the least time possible or to eliminate it altogether.

I believe a fundamental step in minimizing this gap is to ensure that the current programs’ relevant assets, infrastructure, experience, and employee skills are effectively migrated to future programs. Our success as a combined government-industry partnership in addressing this migration will be the key to the efficiency, reliability, safety and overall success of the new programs.

We should remember the impact of the gap between Apollo and Shuttle, not only on local economies (Florida, Texas, California, etc.), but also on our national interest, was severe. NASA had planned for a two-year gap, but it turned into a six-year gap. For all the reasons eloquently stated by NASA Administrator, Mike Griffin, we do not wish to repeat that experience. We learned that without a focused and detailed transition plan, entire national capabilities and human capital assets can be lost—some for an entire generation. When the gap between programs is minimal, as was the case between Gemini and Apollo, crafting a bridge between programs is not as challenging. When the gap is large, as was the case between Apollo and Shuttle, the loss is damaging for our Nation’s economy and technological competitiveness. If we fail, future generations will suffer. Our Nation cannot afford to repeat the mistakes made during the 1970’s.

ISS Completion

NASA has defined 15 additional missions to be flown by September 2010, to complete ISS assembly and provide required logistic support. NASA also has planned one mission for repair and servicing of the Hubble Space Telescope. Mike Griffin has made it clear that safe operation of the Space Shuttle to achieve these 16 flights is NASA’s top priority. This will require adequate NASA top line funding levels in each of the remaining years of Shuttle operation.

Currently, funding for the Constellation program, which includes the new Ares and Orion projects, is not adequate. NASA’s recent announcement that the first crewed flight of Ares I will be delayed is a clear indication that “the gap” in America’s human spaceflight programs is growing. This also sends a signal that additional funding will be required to stem that growth and, if possible, to accelerate development of the Constellation family of vehicles, in order to shorten “the gap” as much as possible.

I recognize the role that political, technical and budget factors must play in determining our approach to achieving ultimate success, and that each factor impacts the others. It is inescapable that a FY 07 budget shortfall will impact technical decisions. A reprioritization of NASA programs by Congress will require a shifting of budget resources from some programs to others. Technical issues can impact both political and budget decisions. We were all reminded that there are factors beyond our control, when a freak hailstorm recently damaged the Shuttle’s external fuel tank. That said, these factors can be managed in balance, a balance that will be determined by the policy and budget decisions you make.

The critical issue is not whether we are technically up to the task. The critical issue is whether resources will be provided to accomplish these tasks.

In my opinion, it’s “gut-check” time. The Administration needs to step up and support the Vision with a request for adequate funding levels for NASA. After all, Congress and the President made the Vision for Space Exploration law when the NASA Authorization Act of 2005 was enacted.

Since the Vision was announced in January 2004, several funding problems have been brought to light. The NASA FY 2005 projected budget run out for FY 2008 was \$18 billion. Now NASA’s budget request is \$17.3 billion. The costs to retire and transition Shuttle in the original FY 2005 budget request were underestimated for FY 08-10 by \$2.4 billion, while the costs to support Space Station were underestimated by \$1.4 billion for that period. Coupled with the unanticipated costs of Return-to-Flight (estimated to be \$2.4 billion) and the addition of a Hubble servicing mission, NASA has been forced to absorb about \$9 billion. To accommodate these shortfalls, NASA has had to cut some programs and slow the development of others.

As you know, NASA’s top line request represents just 1/10 of 1 percent of the Nation’s budget and is \$1.4 billion less than the Congressionally authorized level this

subcommittee approved, and which was signed into law by President Bush. The FY 2007 budget was reduced by about \$700 million due to the Joint Resolution, despite the Senate's leadership in increasing the top line by \$1.1 billion in the reported appropriations bill for FY 2007. Now, neither the FY 2007, nor FY 2008, budgets are adequate to achieve the policy goals established in the Vision.

Please let me take this opportunity to thank you once again for your leadership in supporting a top line increase for NASA's budget during your deliberations on both the authorization and appropriations bills.

The Mikulski-Hutchison Amendment, which proposed to increase the NASA FY 2007 top line, would have helped restore the much-needed resources and help shorten "the gap." Unfortunately, that amendment was never enacted into law and the FY 2008 budget request for NASA does not reflect the real needs of the agency.

President Bush set, and bipartisan majorities in both Houses of Congress approved, the Vision policy goals. After spending billions of the taxpayers' hard-earned dollars, the ISS is finally close to completion. This national asset is ready to start producing results that will positively impact us here on Earth. It therefore remains a responsible policy decision to finish the ISS and meet our international obligations, as well as our obligations to U.S. scientists and researchers who have long been waiting for this unique national laboratory to be open for business.

I understand that members of this committee, as well as members of the Committee on Appropriations, are proposing a "Space Summit" be held with President Bush to discuss both the budgetary and policy issues associated with the Vision. Clearly, the importance of the challenge we face warrants every constructive effort.

The Challenge: Continuity and Change

The primary challenge we face today stems from the need to maintain our human access to space for continued research, discovery, global economic competitiveness and national security, while at the same time closing out the Shuttle program.

These twin tasks are straining NASA's resources in what is clearly a difficult budgetary environment.

Four years ago, this subcommittee heard members of the *Columbia* Accident Investigation Board (CAIB) report that the NASA human spaceflight program, in general, and the Space Shuttle program, in particular, had been starved of necessary funding for nearly a decade. But the CAIB did not stop there; it also reported that the burdens of meeting the schedule for construction and completion of the ISS were leading the Shuttle program to the brink of its safe capabilities. Today, 4 years later, we are confident that the Shuttle is as safe a vehicle as it can possibly be, but we remain concerned about the ever-increasing pressures on NASA's top line budget.

We are once again seeing budget strains across the agency. It is a fact that the NASA budgets prepared and approved before the *Columbia* tragedy were never revised to accommodate the cost of recovery from the accident or the upgrades mandated by the CAIB for Return-to-Flight.

And now, we have the additional factor of transition from Shuttle to Ares/Orion. As the stockpiles of Shuttle-unique hardware reach sufficient levels to support the remaining missions, contracts are not being renewed and the production and manufacturing of many "Shuttle-only" elements are being terminated. These capabilities, once shut down, are costly, or impossible, to restore. Although the Shuttle's final flight is more than 3 years away, many suppliers are exiting the Shuttle program now. We must have a plan in place, soon, and the funds to implement it, if we are to retain skills and apply years of experience to the new missions of exploration.

USA Transition Planning

At United Space Alliance, we have conducted, and will continue to conduct, research into human capital management strategies and options, and we plan to take aggressive measures to help narrow "the gap" through retention of the right skill mix and experience base. Our planning activities are taking into consideration lessons learned from previous programs that implemented terminations and transitions. However, we recognize the Shuttle transition will be the most complex undertaking to date.

The Shuttle program must remain safe and fully operational during its close-out, while transitioning personnel and hardware to the new exploration programs. In the programs benchmarked by our transition planning teams, we found, not surprisingly, that successful transitions involved early identification of critical skills required for retention, retraining requirements, financial incentives, and most importantly, an overarching clear and concise transition roadmap approved up-front by the government and industry partners, which addressed both human capital and hardware. We also found that accurate and regular communication with the work-

force was critical to keeping employees focused on their present jobs, while allowing them to prepare and train for the challenges of new work.

Clearly, USA has a major stake in assuring that the transition process is seamless and successful. For a decade, we have served as the NASA prime contractor for Shuttle operations as well as ground support and mission operations for the ISS. Our challenge is how to best manage this transition and ensure the safety of ongoing Space Shuttle and Space Station operations.

A Critical National Asset

As I stated earlier, I believe the most crucial element for successful transition from Shuttle to the new exploration program is the retention of the current contractor workforce, with its unique skills and unrivaled knowledge of virtually every aspect of space operations. This workforce is essential both to the ongoing safety and success of final Shuttle operations and on the startup of the new exploration programs. Our extensive experience in integrating Shuttle payloads of all kinds will be critical to the successful processing of the different mix of spacecraft that will come on line. The current workforce's knowledge of maintaining a fleet of both human-rated spacecraft and rockets is the only baseline of experience that can be considered pertinent to supporting multiple kinds of Constellation missions. Skills in developing mission manifests, designing EVA and training schedules identifying and addressing flight plan issues and crew equipment, processing and testing spacecraft, and operating and maintaining ground systems, are crucial to planning and executing the low-Earth orbit and lunar exploration missions of the Constellation program.

USA is pursuing a number of options for preserving and developing this irreplaceable national asset for the future. Skills retention is the prime objective of a company-wide initiative that involves workforce training and development, flexible utilization of skills for early Constellation work, retention training for managers and retention incentives for employees. As we evaluate and prioritize our workforce skills, our process will allow us to identify those mission operations and training skills that will be unique to exploring the surface of the Moon, as well as establishing the initial lunar outposts. Above all, Constellation must have a long-range acquisition strategy so that all contractors and suppliers can plan for competitive procurements and project which skills and assets will be needed and when.

We must also plan for the retirement or transition of physical assets. While NASA has identified the major issues facing the industrial base, the ability to engage in transition planning for both hardware and human assets is being hampered by inadequate funding. The Administration has acknowledged the need for a smooth and seamless transition, but as far as I can tell, plans have not been completed for providing NASA the necessary funds to ensure success.

Investing in Our Future

NASA has made large investments in new safety procedures and technologies, to implement the recommendations of the CAIB report. Furthermore, NASA experienced hurricane damage to facilities in 2004 and 2005, that were estimated to cost more to repair than what Congress provided in the supplementals. The cuts to NASA's budget sustained as a result of the FY 2007 Continuing Resolution are serious and will have serious consequences. As I noted, the FY 2008 request does not take those cuts into account.

Administrator Griffin stated, in a letter to Congress, estimated total cost for NASA's Shuttle Return-to-Flight. These funds have been used, among other purposes, to build and deploy foam refinements and tests, to make new cameras and tile inspection sensors, and to develop new repair and inspection technologies, such as the 50-foot inspection boom that has been on prominent display following the return to flight after the *Columbia* accident. Other new costs include systems engineering and integration, additional workforce, and the new NASA Engineering and Safety Center and Independent Technical Authority.

None of these costs were supported with requests for additional funds; each had to be absorbed by NASA's other budgeted activities, thus adding even more pressure to an already austere budget. This makes little sense to me, at a time when we, as a nation, are seeking to enhance our technological competitive capabilities—something in which NASA's programs have historically played a prominent, even preeminent role.

Conclusion

To be sure, there are difficult days ahead in this transition effort. It is essential that we commit our very best efforts to continuing this Nation's tradition of excellence and leadership in space technology and exploration. We have traveled this road twice before in NASA's history. The transitions from Gemini to Apollo, and

Apollo to Shuttle, were challenges that tested our commitment and resolve. If we apply the lessons we've learned from these previous transitions, we will avoid many of the difficulties our predecessors encountered along the way. And, most importantly, if we apply the experience gained from the decades of Shuttle and Station operations to the new Constellation program, we will build on knowledge we have gained from our inspiring work in building our permanently-inhabited laboratory in space.

I want to thank the Subcommittee, again, for this opportunity to come before you today, and I am pleased to answer any questions that you may have.

Senator BILL NELSON. And part of it will be, thanks to the proposal by the successful contractor, part of it will be absorbed in the assembly of the new vehicle down at the space center. Which not only makes good sense in helping retain skill sets, but it also adds an extra set of eyes.

You have the launch team right there next to the assembly team. So you have extra eyes on the problem, and communication, in order to increase the safety of the construction. That will help some. What do you think about that, Mr. Karas?

**STATEMENT OF JOHN C. KARAS, VICE PRESIDENT
AND GENERAL MANAGER, HUMAN SPACEFLIGHT,
LOCKHEED MARTIN SPACE SYSTEMS COMPANY**

Mr. KARAS. Well, I think that is correct Mr. Chairman, I think you are exactly right. It allows us to utilize the workforce that is there. The experienced workforce and a second set of eyes, but also the efficiency, as you mentioned, to help reduce overall ops costs. Because we have manufacturing there.

And as you know, the O&C will be doing manufacturing, final test assembly, launch recovery and refurbishment down there. And we are looking for other opportunities to utilize the workforce down at the Cape, such as putting logistics down there. And there are some other opportunities where there might be other test lab capabilities.

So we are looking to expand our footprint down at the Cape, to help alleviate that problem as best we can.

[The prepared statement of Mr. Karas follows:]

PREPARED STATEMENT OF JOHN C. KARAS, VICE PRESIDENT AND GENERAL MANAGER,
HUMAN SPACEFLIGHT, LOCKHEED MARTIN SPACE SYSTEMS COMPANY

Good afternoon, Mr. Chairman, Senator Hutchison and distinguished Committee members.

I am honored to appear before you today to discuss a critical process of transition that lies before us in the next several years. We should all work together to understand the impact that such a transition will have on key NASA Centers, their employees, their contractors and their communities. Our collective skill in negotiating that transition will determine whether or not America retains its hard-earned mantle of leadership in space science and exploration.

There is a concern that budget pressures may threaten our ability to execute a smooth and timely transition from Space Shuttle operations to a fully developed system of new launch and exploration vehicles. If key schedule milestones are to be met, it is important that all of us in industry and in the government reach agreement on a number of issues. Many of these issues are a product of the tension between long-term budget uncertainties and program technical, schedule, and cost performance.

Working closely together, NASA and the Lockheed Martin Orion team have sought to identify the key ingredients of a successful program and to ensure that they remain part of the recipe. We have imposed rigorous cost controls in order to keep the overall program within the budget constraints set by Congress.

While there are differences of opinion about some elements of the way forward, there is substantial agreement about the priorities: safe and successful fly-out of the Shuttle; and safe, successful, smooth, and affordable transition from Shuttle to the next-generation human spaceflight system. Although Lockheed Martin is now responsible for development of Orion, we also have a vested interest in the successful fly-out of the Shuttle. Not only are we a parent company of United Space Alliance, the company responsible for Shuttle operations, but we also build the External Tank, providing support to the Shuttle program in Texas, Florida, and Louisiana. We're as committed at the front end as we are at the back end.

As we contemplate next steps, the NASA/industry team must accept an important reality: there *will* be an uncomfortable gap between the last Shuttle flight and the first Orion flight. The march of time and the pressure of budget realities virtually guarantee it. Our job is to minimize the gap, develop work-around strategies and execute our development plan as flawlessly as possible.

Some of the work will have to be done serially, some of it will overlap, and some of it will be done in parallel. An example of parallel tasks is the need to continue flying the Shuttle safely while we develop its replacement. In order to do so successfully, we must continue to inspire, motivate and reward the Shuttle workforce while at the same time identifying, recruiting and retaining the new skills and workers that Orion will require.

Similarly, NASA and its prime contractors must provide a programmatic and technical roadmap to key suppliers, one that encourages them to invest in future capabilities while continuing to produce defect-free support for existing systems.

The workforce and the supplier base are both particularly vulnerable to gaps in development, production and operations schedules. Once the pipeline of projects begins to run dry, individuals and businesses begin to head for the exits. As tribal knowledge fades and spare parts dwindle, the risks to existing programs mount and the possibility of new ones diminishes.

Lockheed Martin has recent experience with this kind of dilemma. We have served as the prime contractor on numerous spacecraft development and operations programs that have completed their life-cycle over the past 50 years, repeatedly facing the challenges of transitioning skilled workforce and facilities across programs. During the transitional phases of the Titan and Atlas space booster programs, we gained valuable insight into the most productive ways to achieve mission success while making changes in workforce, facilities and processes.

In 1993, Martin Marietta Corporation bought General Dynamics Space Systems Division, and in the mid-1990s, moved the Atlas operations from San Diego to Denver. This involved the relocation of people and tooling, the construction of facilities and the seamless hand-off of work-in-progress between two sets of workers hundreds of miles apart.

During this transition and workforce relocation, our launch operations team was able to conduct 12 successful Atlas missions. Furthermore, all of the Atlas hardware built during the transition passed inspection and flew successfully on subsequent missions. At the same time, we developed new Atlas variants, incorporating a planned set of improvements, and significantly reduced operations costs. This evolutionary process inspired the Atlas workforce to remain with the program through the challenges of relocation and uncertainty. NASA is off to a good start in much the same way, with the development of Orion, Ares I, Ares V, and the Earth Departure Stage.

As the prospect of downsizing and skill mix adjustments loom in the close-out of Shuttle operations, lessons that we learned at the end of the Titan program are also applicable. In its final years of operation, Titan IV was called upon to launch some of this Nation's most important national security payloads. It was vitally important to maintain a dedicated, skilled workforce as we reached the last missions of the program. Through a combination of re-training and Mission Success incentives, we achieved 100 percent Mission Success through the end of the Titan IV program. Many of the highly-skilled employees that remained on the program to the end are now valued members of the Lockheed Martin Orion team.

What are the keys to success? Good planning, obsessive attention to detail, and most importantly, good change managers to lead during this time of uncertainty.

One element that both the Atlas transition and the Titan close-out had in common was the sense of continuity. The workforce in each case was given clear, honest information about the road ahead. They knew the role that they would play, the importance of the mission, the outlines of the plan, and the arrangements that would protect their jobs or provide for follow-on opportunities. No one had to fear the future.

If the Shuttle-to-Constellation transition is to enjoy the same level of success, we will need to provide the NASA and contractor workforce with a similar sense of con-

tinuity. We will need to communicate our plans for them and for their workplaces. And we will need to take visible steps to mitigate transition-related impacts on job stability.

While the NASA/industry team must develop and execute this transition plan, Congress plays an important role as well. Assured funding and consistent program authorization are key ingredients in providing continuity in program planning. To this end, we commend this committee for your last authorization bill, and urge full support for your FY 08 NASA Authorization.

But it is unlikely that the pressures on Congress will abate anytime soon. Yet there are measures that can be taken to “smooth out the oscillations” as we engineers might say. For example, in bidding for the Orion program, the Lockheed Martin team focused on what we call the “Southern Crescent” approach. Since we knew that low cost would be a crucial element of a winning proposal, we sought to identify cost mitigators that would not jeopardize mission success. The location, condition and particular strengths of the NASA Centers became a key consideration in the proposed siting of Orion work. We fashioned a proposal that leveraged the pre-existing skilled workforce and facilities, the willingness of local communities to invest in the retention of key enterprises, and the logistical advantages conferred by geography. The presence of unique facilities, experienced workers and supportive communities at each NASA Center provided a “win-win” solution.

While our teammate, Orbital is working closely with Langley Research Center on the Launch Abort System and we are working with Glenn Research Center on the Orion Service Module, we and our teammates have located our crew capsule development activities near the southern NASA Centers. This strategy enables us to leverage the invaluable, recent human spaceflight experience, both within NASA and among the many NASA suppliers in the communities. Lockheed Martin’s Orion Project Office and our design and development team are located near JSC in Texas. We are building the Orion structure at the Michoud Assembly Facility in Louisiana. Orion cable harnesses and ground support equipment are being developed and built at Stennis in Mississippi. And Orion final assembly, test, and launch operations will all take place at KSC in Florida. As part of this continuing strategy, we are already working as a subcontractor on the Commercial Orbital Transportation System at Michoud and on the Ares I-1 Avionics Integration contract at Marshall Space Flight Center. Lockheed Martin and our Orion teammates Hamilton Sundstrand, Honeywell and United Space Alliance, are busy with important roles on Shuttle at JSC and KSC. These contracts provide us with unique insight into the dimensions of the workforce transition challenge and facilitate a smoother transition for our second-tier suppliers. We are already identifying opportunities for crossover employment and retraining that can be an element of our workforce utilization strategy.

As we face this transition challenge, care must be taken to keep the promise of these Centers and not squander the institutional and individual competence that has been built up over the years. It is important to ensure clear, open communication with the workforce and the community. The NASA workforce and their community supporters are mature and realistic. If dealt with in a forthright fashion, they will want to stay on the team and be a part of NASA’s future. As we strive to meet strict cost standards, it only makes sense to avail ourselves of existing skills, experienced workers and already-capitalized facilities. To further enable a smooth transition, we must ensure that NASA’s premier facilities are maintained and that obsolete facilities are retired. We encourage expanding NASA’s Enhanced Use Lease authority to guarantee the most efficient use of NASA’s human spaceflight facilities.

To assure successful transition, there must be more than just good intentions. Reliable close-out schedules, retraining opportunities and “bridging” work on other projects are ways in which to preserve workforce loyalty and performance. The Orion team and the NASA Centers are committed to using best practices in managing the human spaceflight transition.

Some of these best practices are proven human resources techniques: skills assessment and inventory, career and vocational counseling, job tracking and database management, skills refreshment and retention, incentive programs, community outreach and local economic development partnerships.

Even with the most effective transition strategies, there will be some inevitable attrition of the workforce. The demographics ensure that we are on the threshold of a significant surge in retirements. Two imperatives arise from this fact: one, knowledge capture and retention must be accomplished proactively through mentoring programs, exit interviews and archiving; second, recruitment must be synchronized and integrated with attrition projections to ensure continuity and knowledge transfer. Performance metrics must be carefully monitored to anticipate and mitigate performance variances in this critical transition period.

Skill mix is one of the most delicate issues that industry must confront. Many find it hard to understand that a contractor could be laying some people off while hiring others at the same time. This process, essential for the health and vitality of the industrial base, can have harsh human consequences. To some extent, retraining and rotational assignments can reduce the need for skill-mix job actions. But the transition from Shuttle to Orion, and the transition from Orion development to Orion operations, will necessarily entail some skill mix adjustments.

We expect to deal with this challenge, in part, through effective community relations. We at Lockheed Martin and our industry teammates have established highly effective relationships with universities, four-year and community colleges, job counselors and State and local government officials. Working with local economic development organizations, we have forged partnerships with the University of Houston, the University of Texas/El Paso, the University of Central Florida, Brevard Community College and a host of other institutions. In the past, workers found themselves adrift without a lifeline when layoffs occurred. Today, with the help of enlightened managers, these community partnerships can provide a more transitional process, combining severance packages, retraining funds, resume preparation and job counseling that often return workers back to the workforce with little or no disruption. While it is in our interest to retain and retrain proven workers, we must also streamline our operations and find new, more efficient ways to accomplish our mission.

Change presents both risk and opportunity. I have spoken of the risks of an ill-conceived transition process for human spaceflight. But the opportunities are well worth remembering. We must encourage a new generation to take up the exciting challenge of space exploration. Powered by new technology, imagination, and Jolt Cola, the next space adventurers will need our help to gain a foothold in the future. At this point, we are finding that recent engineering graduates are clamoring to work on the Orion program. This is a refreshing change, since a decade ago, graduates were leaving the space industry in favor of the exciting opportunities offered by the dot-coms. Congress can maintain this momentum by assuring a sustained investment in people, facilities and technology.

America's most insightful philosopher, Yogi Berra, is reputed to have said "Making predictions is difficult, especially about the future." While I can't predict exactly how the Vision for Space Exploration will turn out, let me say that I am confident in the feasibility of our plan, the competence of our workforce, the maturity of our technology and goodness of our objective. Given the necessary resources, a stable budget, and the continued support of the Congress, I have no doubt of our ultimate success.

Thank you for the opportunity to provide my statement on this important topic. Lockheed Martin appreciates the Committee's interest in maintaining United States leadership in space exploration. We look forward to continuing to work closely with you on these important issues and I look forward to your questions.

Mr. LI. Mr. Chairman?
 Senator BILL NELSON. Yes, Mr. Li?

**STATEMENT OF ALLEN LI, DIRECTOR,
 ACQUISITION AND SOURCING MANAGEMENT, GAO**

Mr. LI. I recognize the importance all these changes that are going to be required in transitioning the workforce. In your discussion about the gap, I think that it needs to be said that providing additional money may not be the only solution and the only way in which, perhaps, we can minimize the gap.

At issue is the confidence in which we know that the budget levels at which we have right now can bring that spacecraft within that time-frame. Everything has to go well. Even with the confidence level that we have right now, it is not certain that we are going to be able to hit 2014 with those budget numbers.

And technology, as I indicated in my prepared statement, there are issues with regards to systems development that without proper knowledge, you just cannot hit those particular milestones. You cannot rush the process. The knowledge needs to be achieved be-

fore you can go to production. And that is pretty much our message.

[The prepared statement of Mr. Li follows:]

PREPARED STATEMENT OF ALLEN LI, DIRECTOR,
ACQUISITION AND SOURCING MANAGEMENT, GAO

Mr. Chairman and members of the Subcommittee:

Thank you for inviting me to discuss the challenges faced by the National Aeronautics and Space Administration (NASA) in transitioning from the Space Shuttle to the next generation of human spaceflight systems. In 2004, the President established a new exploration policy—*A Renewed Spirit of Discovery: The President's Vision for U.S. Space Exploration (Vision)*—which calls for the retirement of the Space Shuttle and the development of a new family of exploration systems. NASA's implementation of the *Vision* is expected to cost hundreds of billions of dollars. A NASA effort of this size and scope has not been seen since the end of the Apollo program and the start of the Space Shuttle program more than 3 decades ago. The transition includes a massive transfer of people, hardware, and infrastructure. Although NASA has in place many processes, policies, procedures, and support systems to carry out this effort, successful transition will depend on thoughtful execution and effective oversight.

The need for NASA to implement the *Vision* in a fiscally prudent and effective manner cannot be overemphasized given the competing fiscal demands facing the Federal Government and an already troubling funding profile projected for human spaceflight activities. We have issued a number of reports that touch on various aspects of retiring the Space Shuttle and transitioning its assets and people to exploration activities. These reports have questioned the affordability of the exploration program, NASA's acquisition strategy for the development of new space vehicles, agency-wide contract management, and workforce planning for current and future agency needs. We also have an ongoing body of work being performed at the request of the House Committee on Science and Technology regarding effective management of the industrial base, development of the Ares I Crew Launch Vehicle, and the logistical support needed by the International Space Station (ISS). In addition, at the request of the Senate Committee on Homeland Security and Governmental Affairs, Subcommittee on Oversight of Government Management, the Federal Workforce, and the District of Columbia, we are reviewing NASA's ability to attract and retain a skilled workforce. My statement today will focus on the overarching challenges that NASA faces in transitioning from the Shuttle to the next generation of human spaceflight systems and will discuss our prior work on Shuttle workforce and development of the Orion Crew Exploration Vehicle, one of the agency's complex programs. I will also discuss areas where we have related ongoing work.

This testimony is based on work conducted in accordance with generally accepted government auditing standards.

Summary

NASA faces numerous challenges as it transitions from the Space Shuttle program to the next generation of human spaceflight systems. We have undertaken a body of work over the past 3 years that has highlighted two of these challenges—sustaining the Shuttle workforce and developing new systems. Sustaining the Shuttle workforce through retirement and ensuring that the workforce is available to support future exploration activities presents an enormous challenge for NASA. In 2005, we reported that NASA has made limited progress toward developing a detailed strategy to retain a critically skilled workforce for Shuttle operations. We recommended that the agency begin identifying the Shuttle program's future workforce needs. NASA has recognized that Shuttle workforce management and critical skills retention will be a major challenge and has taken action to address this issue. In 2006, we reported that NASA's acquisition strategy for the Orion Crew Exploration Vehicle was risky because it committed the Government to a long-term contract before establishing a sound business case. We recommended that NASA modify the current Orion Crew Exploration Vehicle acquisition strategy to ensure that the agency does not commit itself to a long-term contractual obligation prior to establishing a sound business case. Although it initially disagreed with our recommendation, NASA subsequently revised its acquisition strategy to address some of the concerns we raised.

We are currently conducting a body of work relating to the transition, including NASA's management of the supplier base, development of the Crew Launch Vehicle, and logistical support of the Space Station. Our work to date has also identified

other issues that NASA will face during the transition, including disposing of property and equipment, completing environmental clean up, managing the overall workforce, and integrating financial information into how NASA does business. Each area contains its own set of unique challenges, but they are all critical to NASA's overall transition effort and will require significant management attention.

Background

The President's Vision for Space Exploration for NASA announced in 2004 calls for the retirement of the Shuttle upon completion of the ISS and the creation of new vehicles for human spaceflight that will allow a return to the Moon by 2020 and voyages to Mars and points beyond. The Shuttle manifest currently consists of 16 flights—15 to complete assembly and integration of the ISS and a servicing mission¹ to the Hubble Space Telescope. The first new space vehicles currently are targeted to begin operating no later than 2014—thereby creating a potential gap in U.S. human spaceflight. Congress has voiced concern over the United States not having continuous access to space. NASA has made it a priority to minimize the gap to the extent possible.

NASA has begun planning for the retirement of the Shuttle, scheduled for 2010, by identifying best practices in closing facilities and the transitioning of capabilities. Specifically, NASA has conducted a number of benchmarking studies of previous closures and realignment of large programs, including the Titan IV rocket fly-out, the F/A-18 C/D fighter production close, and the Navy Base Realignment and Closure activities. The benchmarking efforts have highlighted to NASA the importance of having a plan, effective communication, human capital management, and effective program management tools. NASA's benchmarking effort also showed that closing and transitioning facilities, equipment, and people is expensive and time consuming. Among the lessons learned is that, historically, it has taken 3.5 years to close down an installation and another 3 years to complete the transition of the property. NASA's Office of the Inspector General has recently reviewed NASA's plan for the Space Shuttle transition and recommended, among other improvements, that the two affected space directorates finalize and implement the Human Space Flight Transition Plan.²

Development of the Orion crew capsule, Ares I launch vehicle, and other exploration systems needed to implement the *Vision* is dependent on a "go as you can afford to pay" approach, wherein lower-priority efforts will be deferred, descoped, or discontinued to allow NASA to stay within its available budget profile. In recent testimony, the NASA Administrator said that the cost associated with returning the Shuttle to flight, continued Shuttle operations, and recent budget reductions had the combined effect of increasing the gap by delaying the first manned Orion test flight by 6 months.

In an effort to address the gap in U.S. capability to resupply the Space Station following retirement of the Shuttle, NASA is investing in commercial space transportation services. NASA's expectation is that by acquiring domestic orbital transportation services it will be able to send cargo and, in the future, transport crews to the ISS in a cost-effective manner. NASA refers to this as the Commercial Orbital Transportation Services project. The project is in the early stages of development. Should these commercial services prove to be unreliable or more costly than anticipated, NASA will need to purchase space transportation from its International Partners to meet obligations to the ISS until the new Orion spacecraft become operational.

NASA Faces Significant Challenges in Retiring the Space Shuttle Program and Transitioning to Exploration Activities

We have undertaken a substantial body of work over the past 3 years that has highlighted the significant challenges that NASA will face as it retires the Shuttle and transitions to exploration activities. One key challenge is sustaining the Shuttle workforce through the retirement of the Shuttle while ensuring that a viable workforce is available to support future activities. Another key challenge will be developing the Orion Crew Exploration Vehicle within cost, schedule, and performance goals. Additionally, our ongoing work has identified a number of other areas that may present challenges during the transition period. Some of these challenges in-

¹The servicing mission includes installing the Cosmic Origins Spectrograph and Wide Field Camera 3, installing a refurbished Fine Guidance Sensor that replaces one degrading unit of the three already onboard, and an attempt will also be made to repair the Space Telescope Imaging Spectrograph, which stopped working in 2004.

²NASA Office of Inspector General. *NASA's Plan for Space Shuttle Transition Could Be Improved by Following Project Management Guidelines*, IG-07-005, (Washington, D.C.: Jan. 29, 2007).

clude managing the supplier base to ensure its continued viability, developing the Ares I Crew Launch Vehicle, and completing and supporting the Space Station.

Maintaining a Skilled Workforce

The Space Shuttle program's workforce is critical to the success of the *Vision*. The Shuttle workforce currently consists of approximately 2,000 civil service and 15,000 contractor personnel, including a large number of engineers and scientists. In 2005, we reported that NASA had made limited progress toward developing a detailed strategy for sustaining a critically skilled Shuttle workforce to support Space Shuttle operations. We reported that significant delays in implementing a strategy to sustain the Shuttle workforce would likely lead to larger problems, such as funding and failure to meet NASA program schedules. Accordingly, we concluded that timely action to address workforce issues is critical given their potential impact on NASA-wide goals such as closing the gap in human spaceflight.

When we performed our work several factors hampered the ability of the Space Shuttle program to develop a detailed long-term strategy for sustaining the critically skilled workforce necessary to support safe Space Shuttle operations through retirement. For example, at that time, the program's focus was on returning the Shuttle to flight, and other efforts such as determining workforce requirements were delayed. In our report, we recommended that NASA begin identifying the Space Shuttle program's future workforce needs based upon various future scenarios. Scenario planning could better enable NASA to develop strategies for meeting future needs. NASA concurred with our recommendation. It has acknowledged that Shuttle workforce management and critical skills retention will be a major challenge for the agency as it progresses toward retirement of the Space Shuttle and has taken action to address this issue. For example, since we made our recommendation, NASA has developed an agencywide strategic human capital plan and developed workforce analysis tools to assist it in identifying critical skills needs. NASA has also developed a human capital plan specifically for sustaining the Shuttle workforce through the retirement and, then transitioning the workforce.

Additionally, in March 2006, the Senate Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies, and NASA asked the National Academy of Public Administration (NAPA) to assist the agency in planning for the Space Shuttle's retirement and transition to future exploration activities. In February 2007, a NAPA panel recommended that the Space Shuttle program adopt a RAND model for projecting a core workforce because of its emphasis on "long-term scheduling projections, quantification of core competencies and proficiencies, and analysis of overlapping mission needs."³ Under the RAND model, an organization maintains a core capability for any competency that will be needed in the future. According to NAPA, this model is useful where a given expertise is not immediately required, but is likely to be needed in the future—in this case, for the Orion Crew Exploration Vehicle.

Developing New Exploration Systems

In July 2006, we reported that NASA's acquisition strategy for the Orion Crew Exploration Vehicle placed the project at risk of significant cost overruns, schedule delays, and performance shortfalls because it committed the Government to a long-term contract before establishing a sound business case.⁴ Our past work has shown that developing a sound business case—one that matches requirements to available and reasonably expected resources before committing to a new product development effort—reduces risk and increases the likelihood of successful outcomes.⁵ For a program to increase its chances of success, high levels of knowledge should be demonstrated before significant commitments are made (*i.e.*, they should be following a knowledge-based approach to product development).

At the time of our report, NASA had yet to develop key elements of a sound business case, including well-defined requirements, mature technology, a preliminary

³NAPA also recommended that NASA adopt scenario planning into its agencywide workforce planning processes and use the results to inform decisionmaking.

⁴GAO, *NASA: Long-Term Commitment to and Investment in Space Exploration Program Requires More Knowledge*, GAO-06-817R (Washington, D.C.: July 17, 2006).

⁵Examples of our best practices reports include GAO, *Best Practices: Using a Knowledge-Based Approach to Improve Weapon Acquisition*, GAO-04-386SP (Washington, D.C.: Jan. 2004); *Space Acquisitions: Committing Prematurely to the Transformational Satellite Program Elevates Risks for Poor Cost, Schedule, and Performance Outcomes*, GAO-04-71R (Washington, D.C.: Dec. 4, 2003); *Best Practices: Capturing Design and Manufacturing Knowledge Early Improves Acquisition Outcomes*, GAO-02-701 (Washington, D.C.: July 15, 2002); and *Best Practices: Better Matching of Needs and Resources Will Lead to Better Weapon System Outcomes*, GAO-01-288 (Washington, D.C.: Mar. 8, 2001).

design, and firm cost estimates that would support its plans for making a long-term commitment. Without such knowledge, NASA cannot predict with any confidence how much the program will cost, what technologies will or will not be available to meet performance expectations, and when the vehicle will be ready for use. NASA acknowledged that it would not have these elements in place until the project's Preliminary Design Review scheduled for Fiscal Year 2008. As a result, we recommended that the NASA Administrator modify the agency's acquisition strategy for the Orion Crew Exploration Vehicle to ensure that the agency does not commit itself, and in turn the Federal Government, to a long-term contractual obligation prior to establishing a sound business case at the project's Preliminary Design Review.

Although it initially disagreed with our recommendation, NASA subsequently took steps to address some of the concerns we raised. Specifically, NASA modified its acquisition strategy for the Orion project and changed the production and sustainment portions of the contract into options. The agency will decide whether to exercise these options after the project's Critical Design Review in 2009. While these changes are in line with our recommendation and a step in a positive direction, we continue to believe NASA's acquisition strategy is risky because it does not fully conform to a knowledge-based acquisition approach. Attempting to close that gap by pushing forward development of the Orion Crew Exploration Vehicle without first obtaining the requisite knowledge at key points could very well result in the production of a system that not only does not meet expectations but ends up costing more and actually increases the gap.

Since we last testified on this subject in September 2006,⁶ NASA has successfully completed its first major milestone for the Orion project. It has completed the Systems Requirements Review.⁷ This was a major step toward obtaining the information critical for making informed decisions. According to NASA's Orion contracting officer, NASA is also in the process of renegotiating the Orion contract to extend the Initial Operational Capability date of the system to 2014. Further, while this change will increase contract costs, the increase has already been accounted for in the Orion budget because the agency has been planning the change for over a year. In addition, risks associated with schedule, cost, and weight continue to be identified for the Orion project.

As we have previously testified, sound project management and oversight will be key to addressing the risks that remain for the Orion project as it proceeds with its acquisition approach. To help mitigate the risks, we have recommended in the past that NASA have in place markers (*i.e.*, criteria) to assist decisionmakers in their monitoring of the project at key junctures in the development process. Such markers are needed to provide assurance that projects are proceeding with and decisions are being based upon the appropriate level of knowledge and can help to lessen project risks. NASA has recently issued its updated program and project management requirements for flight systems in response to our recommendation. Changes to the policy,⁸ including the incorporation of key decision points throughout the project development life-cycle, should provide an avenue for decisionmakers to reassess project decisions at key points in the development process to ensure that continued investment is appropriate. However, it should be noted that implementation of the policy in a disciplined manner will ensure success, not the existence of the policy itself.

Currently, we are evaluating the development of NASA's latest human-rated launch vehicle—the Ares I Crew Launch Vehicle. When completed, the Ares I vehicle will be capable of delivering the Orion spacecraft to low-Earth orbit for ISS missions and for exploration missions to the Moon. As initially conceived by NASA in the Exploration Systems Architecture Study completed in 2005, the Ares I design would rely on the existing solid rocket boosters and main engines from the Space Shuttle as major components of its two stages. The current design for the Ares I, however, diverges from the initial design set forth in the architecture study and now includes elements from the Apollo-era Saturn V launch vehicle. Current plans are for Ares I to evolve the solid rocket boosters from the Space Shuttle program from

⁶ GAO, *NASA: Sound Management and Oversight Key to Addressing Crew Exploration Vehicle Project Risks*, GAO-06-1127T (Washington, D.C.: Sept. 28, 2006).

⁷ According to NASA's Systems Engineering Procedural Requirements (NASA Procedural Requirements NPR 7123.1), the SRR examines the functional and performance requirements defined for the system and the preliminary program or project plan and ensures that the requirements and the selected concept will satisfy the mission.

⁸ NASA Procedural Requirements (NPR) 7120.5D establishes the requirements by which NASA will formulate and implement spaceflight programs and projects. NPR 7120.5D became effective on March 6, 2007, and supersedes the previous version of the document, NPR 7120.5C, for spaceflight programs and projects.

four segments to five segments and to build a new upper-stage engine based on an original Saturn V design. NASA maintains that these changes are necessary to increase commonality between the Ares I and the planned Ares V cargo launch vehicle and to reduce overall development costs for implementing the *Vision*. As NASA's design for the Ares I continues to evolve, careful planning and coordination between the Orion and Ares I development teams will be critical to ensuring that current developmental efforts result in hardware that satisfies the future requirements of these systems. Subsequently, any development problems on either of these systems could result in increasing the gap.

Our ongoing work is aimed at assessing whether NASA's acquisition strategy for Ares I reflects the effect of changes to the Ares I design incorporated since the Ares I was first conceived in the Exploration Systems Architecture Study as a Shuttle-derived alternative. Also, we are evaluating the extent to which NASA's Ares I acquisition strategy incorporates knowledge-based concepts designed to minimize technical and programmatic risk.

The Orion Crew Exploration Vehicle and the Ares I Crew Launch Vehicle are the first in a series of new systems to be developed in support of exploration activities. NASA's careful management of these projects must preclude historical instances of cost and schedule growth. Indeed, while NASA has had many successes in the exploration of space, such as landing the Pathfinder and Exploration Rovers on Mars, NASA has also experienced its share of unsuccessful missions, unforeseen cost overruns, and difficulty bringing a number of projects to completion. For example, NASA has made several attempts to build a second generation of reusable human spaceflight vehicle to replace the Space Shuttle, such as the National Aero-Space Plane, the X-33 and X-34, and the Space Launch Initiative, that never accomplished its objective of fielding a new reusable space vehicle. We estimate that these unsuccessful development efforts have cost approximately \$4.8 billion since the 1980s. The high cost of these unsuccessful efforts and the potential costs of implementing the *Vision* make it important that NASA achieve success in developing new systems for its new exploration program.

Managing the Supplier Base Throughout Retirement and Transition

NASA's plans to retire the Shuttle have the potential to greatly impact the supplier base that has been supporting that program for the last several decades, as well as mold the future supplier base needed for its exploration program. Over the next few years, NASA will be making decisions about its supplier base needs, including which suppliers will be required for the remainder of the Space Shuttle program, which will no longer be required for the program, and which will be needed to support exploration efforts. One concern is that NASA will be unable to sustain suppliers necessary to support the exploration program during the period between the Shuttle's retirement and resumption of human spaceflight. Also of concern is that those suppliers determined by NASA as not needed for the exploration program will prematurely end their services, thus jeopardizing the safe and efficient completion of Shuttle activities. In addition, issues such as obsolescence—already being experienced by some Shuttle projects—could have an impact on the exploration program given the planned use of heritage hardware for some components of the Constellation projects. In an attempt to address these potential issues, NASA has been developing and implementing plans and processes to manage the transition of its supplier base.

We are in the process of assessing how well NASA is positioning itself to effectively manage its supplier base to ensure both sustainment of the Space Shuttle program through its scheduled retirement in 2010 and successful transition to planned exploration activities.

Providing Logistical Support to the International Space Station

The Shuttle is uniquely suited for transporting crew and cargo to and from the ISS. However, with scheduled retirement of the Shuttle in 2010, NASA and its International Partners will be challenged to fully support ISS operations until 2014, when the new crew exploration vehicle is scheduled to come on line. To fill this gap, NASA plans to rely on its International Partners and commercial services to provide ISS logistics and crew rotation.

Two recent studies have raised serious concerns about whether future ISS operations can be continuously supported. A 2006 report by the National Research Council noted that the capabilities, schedules, and funding requirements for NASA, International Partners, and commercial cargo and crew vehicles were not yet firm enough to give the panel confidence that ISS exploration mission objectives have a

high likelihood of being fulfilled.⁹ A February 2007 report by the International Space Station Independent Safety Task Force, which was required by the NASA Authorization Act of 2005,¹⁰ noted that the transition from the Space Shuttle to post-Shuttle systems for logistical support to the ISS will require careful planning and phasing of new capabilities. Specifically, care must be taken to ensure adequate logistics and spares are provided to maintain a viable station.¹¹ The task force report went on to say that if a commitment is made to an emerging logistics delivery capability and the capability does not materialize, then logistical support to the ISS could be lost for some time, seriously decreasing the utility of the Space Station and possibly resulting in its abandonment.

We are reviewing NASA's plans for meeting ISS logistics and maintenance requirements after the Shuttle retires, identifying the main risks to meeting ISS logistics and maintenance requirements, and assessing NASA's plans for addressing the risks.

Disposing of Property and Equipment

NASA has not developed a comprehensive cost estimate for transitioning or disposing of Space Shuttle program facilities and equipment. This poses a financial risk to the agency. As NASA executes the remaining missions needed to complete the assembly of and provide support for the ISS, it will simultaneously begin the process of disposing of Shuttle facilities and hardware that the Space Shuttle program will no longer need, or, transitioning such facilities and hardware to the other NASA programs.¹² As the ninth largest Federal Government property holder, NASA owns more than 100,000 acres, as well as over 3,000 buildings and 3,000 other structures totaling over 44 million square feet. Currently, the Space Shuttle program uses 654 facilities valued in excess of \$5 billion. The Space Shuttle program also manages equipment dispersed across government and its contractors valued at more than \$12 billion. NASA is in the process of evaluating its Space Shuttle program facilities and equipment requirements and identifying existing facilities and equipment that will no longer be needed to support Shuttle operations. Constellation and other NASA programs will determine whether they need any of the facilities or equipment released by the Space Shuttle program. According to NASA officials, assessments currently project that only 70 to 80 of the existing facilities are needed to support the development or operation of future exploration systems. In cases where facilities or equipment are no longer required by the Space Shuttle program, no other use is identified, or it is selected for disposal, it will transition to the resident NASA field center for disposition.

It is worth noting that even before the retirement of the Shuttle, over 10 percent of NASA's facilities are underutilized or not utilized at all. One option NASA has is to lease underutilized facilities in exchange for cash and/or in-kind consideration, such as improvement of NASA's facilities or the provision of services to NASA. As directed by the NASA Authorization Act of 2005, we recently reported on NASA's Enhanced Use-Leasing Program.¹³ Congress authorized NASA to employ enhanced-use leasing at two demonstration centers. This allowed the agency to retain the proceeds from leasing out underutilized real property and to accept in-kind consideration in lieu of cash for rent. The Act allows NASA to deposit the net proceeds (*i.e.*, net of leasing costs) in a no-year capital account to use later for maintenance, capital revitalization, and improvement of the facilities, albeit only at the demonstration centers—Ames Research Center and Kennedy Space Center. However, unlike other agencies with enhanced-use leasing authority, NASA is not authorized to lease back the property during the term of the lease. Furthermore, we found that the agency does not have adequate controls in place to ensure accountability and transparency and to protect the Government. We recommended that the NASA Administrator develop an agency-wide enhanced use leasing policy that establishes controls and processes to ensure accountability and protect the Government's interests including developing mechanisms to keep the Congress fully informed of the agency's enhanced use leasing activity. NASA concurred with our recommendations. After not receiving additional authority in the NASA Authorization Act of 2005, the agen-

⁹Review of NASA Plans for the International Space Station, National Research Council, Washington, D.C., 2006.

¹⁰Pub. L. 109-155, §§ 802, 804 (2005).

¹¹Final Report of the International Space Station Independent Safety Task Force, February 2007.

¹²Facilities refers to real property such as land, buildings and other structures that cannot be readily moved, and equipment refers to personal property that could be transported elsewhere with relative ease.

¹³Pub. L. 109-155, § 710 (2005) and GAO, *NASA: Enhanced Use Leasing Program Needs Additional Controls*, GAO-07-306R (Washington, D.C.: Mar. 1, 2007).

cy is again requesting that the Congress extend enhanced use leasing authority to at least six NASA centers. NASA currently has other leasing authorities, but they require the agency to return to the U.S. Treasury any amounts exceeding cost. Further, NASA has indicated that it is preparing a package of legislative and administrative tools to help in the transition from the Space Shuttle program to the Constellation program. For example, in addition to requesting authority for increased use of enhanced use leasing, a NASA official informed us that one tool the agency might consider pursuing is the ability to keep the funds within NASA from the sale of facilities and equipment, rather than returning such funds to the Treasury.

Completing Environmental Clean Up

NASA does not have a comprehensive estimate of the environmental clean up costs associated with the transition and disposal of Space Shuttle program facilities and equipment. The agency must comply with Federal and state environmental laws and regulations, such as the National Environmental Policy Act of 1969, as amended,¹⁴ the Resource, Conservation, and Recovery Act of 1976, as amended,¹⁵ and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended,¹⁶ in identifying and mitigating the environmental concerns. Although NASA has an approach for identifying environmental risks, in our report on major challenges facing the Nation in the 21st century, we pointed out that progress in cleaning up sites frequently does not meet expected time-frames and the costs dramatically exceed available funding levels.¹⁷ For example, it cost the Titan IV program approximately \$300 million over 6 years on cleaning facilities, equipment, and tools. At this time, the extent of the Space Shuttle program's environmental liabilities is not yet fully known. Paying for this liability may require a significant future outflow of funds at the same time that NASA will be facing many other competing demands for its limited dollars, such as development of Orion, Ares I, and other exploration projects.

Positioning the Science, Engineering, and Technical Workforce

As it moves away from flying the Shuttle, the NASA acknowledges that it must realign where necessary and plan for a workforce that will not be quite as large. NASA projects fewer resources will be required for operating and sustaining hardware, especially during vehicle processing and launch operations. The reduction in reusability of future space systems will also result in less refurbishing. In addition, as new space systems are designed, emphasis will shift to personnel with skills in systems development and engineering, program management and systems integration. Unfortunately, these skills will be in high demand at a time when other Federal agencies and the private sector have similar needs.

NASA projects that by Fiscal Year 2012 the total number of personnel needed to meet its strategic goals will decrease from 18,100 to 17,000. The agency is taking advantage of the flexibilities outlined in the NASA Flexibility Act of 2004¹⁸ to attract highly qualified candidates, however, continued buy-outs and the threat of a reduction in force have created a feeling of instability among the science and engineering workforce. NASA's senior leaders recognize the need for an effective workforce strategy in achieving mission success. NASA has a strategic human capital plan, but more work is needed in workforce planning and deployment. In addition, NASA's transition to full cost accounting in Fiscal Year 2004 resulted in a number of its centers experiencing less than Full Time Equivalent utilization, a situation referred to by NASA as "uncovered capacity." The Administrator has committed to operating and maintaining 10 centers and transferred work to those centers with identified uncovered capacity.

We are examining whether several Federal agencies, including NASA, are taking sufficient steps to address their workforce challenges in a timely and comprehensive manner, while sustaining focus on its mission and programmatic goals. Specifically, we are assessing the extent to which NASA's human capital framework is aligned with its strategic mission and programmatic goals; whether NASA is effectively recruiting, developing, and retaining critically skilled staff; and what internal or external challenges NASA faces in achieving its workforce needs. As noted earlier, NAPA recently completed a study that made recommendations to NASA on how to achieve a flexible and scalable workforce by integrating its acquisition and workforce planning processes.

¹⁴ 42 U.S.C. § 4321, et seq.

¹⁵ 42 U.S.C. § 6901, et seq.

¹⁶ 42 U.S.C. § 9601, et seq.

¹⁷ GAO, *21st Century Challenges: Reexamining the Base of the Federal Government*, GAO-05-325SP (Washington, D.C.: February 2005).

¹⁸ Pub. L. 108-201.

Transforming the Way Financial Information Is Used

Since 1990, GAO has designated NASA's contract management as high risk principally because NASA has lacked a modern financial management system that can provide accurate and reliable information on contract spending and has placed little emphasis on product performance, cost controls, and program outcomes.¹⁹ NASA has made progress toward implementing disciplined project management processes, but it has made only limited progress in certain areas such as reengineering NASA's contractor cost reporting process. As we reported, the current Integrated Enterprise Management Program does not provide the cost information that program managers and cost estimators need to develop credible estimates and compare budgeted and actual cost with the work performed on the contract. NASA plans to spend billions of dollars to develop a number of new capabilities, supporting technologies, and facilities that are critical to enabling space exploration missions. The development of such capabilities will be largely dependent on NASA contractors—on which NASA spends about 85 percent of its annual budget. Because of such a large reliance on contractors to achieve its mission, it is imperative that NASA be able to track costs and the means to integrate financial decisionmaking with scientific and technical leadership by providing decisionmakers accurate information. To its credit, NASA is working to improve business processes and integrating disparate systems in order to improve efficiencies, reduce redundant systems, and improve business information available to the acquisition community and mission support organizations. However, more effort will be needed to make the cultural transformation a reality.

Concluding Observations

The Vision for Space Exploration puts NASA on a bold new mission. Implementing the *Vision* over the coming decades will require hundreds of billions of dollars and a sustained commitment from multiple Administrations and Congresses over the length of the program. How well NASA overcomes the transition challenges that we and others have identified will not only have an effect on NASA's ability to effectively manage the gap in the U.S. human access to space, but also will affect the agency's ability to secure a sound foundation of support for the President's space exploration policy. Consequently, it is incumbent upon NASA to ensure that these challenges are being addressed in a way that establishes accountability and transparency to the effort.

Mr. Chairman and members of the Subcommittee, this concludes my prepared statement. I would be happy to answer any questions you may have at this time.

Senator BILL NELSON. I am being advised by the people who should know, Mr. Gerstenmaier's outfit, that with that funding profile they can hit those milestones. Are you saying something different?

Mr. LI. What I am saying is that the basis on which they have made that particular statement is based upon a confidence level of 65 percent. That is what the Administrator indicated about 2 weeks ago.

What that means is that there is only a certainty of 65 percent. What I believe this particular Subcommittee and the rest of the Congress, perhaps, can ask NASA, is to follow their own rules, and say if you went to 70 percent, which many of their programs are at, if you had to achieve 70 percent confidence level, what is that delta in terms of dollars that are needed? And then the Congress would be better informed as to what those impacts would be.

Senator BILL NELSON. OK. We will look at that. Would somebody tell me how many minutes I have left to vote? Sorry for the interruption, but this is a part of our lives. And we have not figured out how to clone ourselves yet to be in two places at once.

Mr. Dittmore, you are doing the rockets on which this spacecraft is going to sit. Give us your perspective on this.

¹⁹GAO, *High-Risk Series: An Update*, GAO-07-310 (Washington, D.C.: Jan. 2007).

**STATEMENT OF RONALD D. DITTEMORE, PRESIDENT,
ATK LAUNCH SYSTEMS GROUP**

Mr. DITTEMORE. I think NASA has made some extremely smart moves. Number one, they have gone a long way toward mitigating many of our technical, our skills, our processing, and even our costs risk by utilizing proven technologies that already exist.

What we are talking about now is going the extra step to make sure we do not lose a skill set that may be perishable over an extended gap. I think that these early moves to utilize that proven technology will pay benefits long into the future, because they are retaining skills, precious skills that would otherwise be off the program. And they are doing that today. So I think that is a great first step.

I totally believe that we need to minimize the gap. Any extension of the gap is only going to exacerbate a transition issue. And so I am going to urge you and everybody else that we really need to provide the necessary resources, stable resources, so that NASA and industry can join together and put a plan together that is executable and provides for the safety of the astronauts, as we fly-out the Shuttle program, and as we transition to the next program.

So I think we are starting out on a very good path. Now we are talking about how do we continue that and execute it to the finish line.

[The prepared statement of Mr. Dittimore follows:]

PREPARED STATEMENT OF RONALD D. DITTEMORE, PRESIDENT,
ATK LAUNCH SYSTEMS GROUP

Mr. Chairman and members of the Subcommittee, thank you for the opportunity to appear today to discuss transitioning to a next generation human spaceflight system.

I, along with many of my colleagues, am a product of the first great vision to land a man on the Moon and return safely to Earth. The excitement of Mercury, Gemini, and Apollo captivated our attention and stirred our imaginations. As a direct result of this excitement, Aerospace engineering became my particular field of study and I was extremely fortunate to have a tremendous career with NASA for over 26 years.

I am pleased to address the issue of transition from the Space Shuttle to the new Ares/Orion launch system. It is an important issue facing us today as we approach a crossroads where the transition between space transportation systems will be critical in our ability to maintain skills and experience while training a new generation of space scientists, engineers, and processing workforce.

But before I address the transition from the Space Shuttle to the new Ares launch transportation system, it is worth reviewing previous experience with transitions of this magnitude, particularly the transition from the Apollo program and Saturn V launch vehicle to the Space Shuttle transportation system. After the Apollo Moon landings ended in 1972, several small transitions, or "soft landings" occurred. Significant workforce reductions occurred both within the NASA civil service workforce and private industry. Follow-on programs did not need the levels of workforce that were required during the buildup to support the Moon landings of the late 1960s and early 1970s. A leaner NASA and a leaner industry were the result.

During this transitional phase, NASA developed and operated its first Space Station, Skylab. And after Skylab's three missions were completed an international cooperative mission between the United States and Russia, Apollo/Soyuz, was conducted. These missions constituted "soft landings" where critical skills and experience were retained as workforce reductions and attrition occurred.

Fast-forwarding 30 years to 2007, the lessons of the Apollo/Shuttle transition are applicable today as NASA transitions from Shuttle to Ares I/Orion. Actions taken have already resulted in several "soft landings" where critical skills and experience are being directly applied to new program development. Many of the technical, skill, processing, and cost challenges have been mitigated through the utilization of prov-

en Shuttle derived capabilities for the foundation of the Ares I launch vehicle. Critical industry skill and experience are being retained in the development of the Ares I systems.

Additionally, an Ares I test flight program is being developed that bridges the gap between the last Shuttle flight and the start of Ares I operational capability, utilizing the talents across industry and NASA's field centers. These test flights provide an avenue of transition where critical skills and experience are captured and retained.

And just as the Skylab Space Station provided a bridge between Apollo and Shuttle for the retention of critical skills, I believe that the operation of the International Space Station through at least the middle of the next decade is necessary to provide a similar bridge between the Space Shuttle and future lunar missions.

But there is no doubt that the transition from the 25-plus year Space Shuttle program to the new Ares I transportation system will be a significant challenge. Resources must be allocated to allow for a safe and executable transition, providing for the safety of our astronauts as the Shuttle program comes to a close and enabling the execution of these "soft landings" as I have described. Increasing the gap between Shuttle and Ares I exacerbates the transition. The gap, in my opinion, should be minimized and resources allocated to ensure this occurs.

As industry, small and large, across this country step up to the challenge, we have the opportunity to drive down cost and to realign contracts to be much more efficient. And although this transition period will be challenging, it also presents a gateway to new opportunity as the end-state vision associated with Ares I begins to evolve. People will change badges; people will step up to the challenge of being retrained; and people will aggressively seek new positions of growth provided by an expanding vision.

With a safer, more economical launch system come increased opportunities. Instead of servicing only one program, the Kennedy Space Center has the potential to be the spaceport of the future for a variety of missions—Ares I NASA missions to low-Earth orbit, potential Ares I commercial applications, and providing services and infrastructure for a growing Commercial Orbital Transportation System (COTS) that NASA is facilitating. The evolution of the space industry is continuing and Ares I opens up potential new opportunities for industry to develop. The opportunity exists for the transition of workforce skills and experience at the KSC to support a broader KSC role.

It is also evident that the KSC launch site is becoming an extension of the manufacturing centers where Ares I launch vehicle element refurbishment and assembly and Orion spacecraft assembly are major activities in addition to integrated vehicle processing and launch/recovery operations. The KSC workforce will have opportunities to transition from Shuttle contracts to Ares I contracts to support these Ares I/Orion assembly activities.

As we continue to pursue The Vision for Space Exploration and transition to a new space transportation system, a new generation of scientists and engineers will be inspired, as was my generation 30 years ago. The transition that I have addressed will certainly be a challenge, but it also represents significant opportunities for the future. With the necessary resources, I am confident that NASA and industry will rise to the challenge and safely guide us to the next great adventure.

Senator BILL NELSON. I am going to give you a list of Senators I want you to talk to.

[Laughter.]

Senator BILL NELSON. Mr. Walker, of course your folks are the greatest launch team in the world, without exception. I am sure there are some stirrings down there at home. Folks are uncertain.

STATEMENT OF JOHNNY WALKER, DIRECTING BUSINESS REPRESENTATIVE, DISTRICT LODGE 166, INTERNATIONAL ASSOCIATION OF MACHINISTS AND AEROSPACE WORKERS

Mr. WALKER. I cannot do anything but reflect what these gentlemen are telling you here today, that we—we lived through the Apollo—end of the Apollo program, and waited for the Shuttle program to come along. And it was pretty devastating.

Certainly, the launch team is nervous. All the folks from the Cape are nervous just wondering what is going to be there for the future.

I am just—just in reflecting and saying, to us, it is to push along today the best we possibly can, fund it, fund the program, so that we do not have this break in the team concept, and not make the mistakes that we made in the past.

But certainly, I think my main mission here today was to tell you that the workforce is nervous. And I would love to see, actually, that we share a little bit more information with the launch team and with the folks there at the Cape. A little more than what we have been.

I think, certainly, if they know things like this are going on, that it will be better for morale. Knowing that we are trying to save and trying to utilize the stuff that we currently have, and reflecting on that.

We are going to be emptying out facilities when the—come the end of this program. This great program that we have been a part of. And I would love to see this try to bring in the work to maintain this workforce that we currently have here.

[The prepared statement of Mr. Walker follows:]

PREPARED STATEMENT OF JOHNNY WALKER, DIRECTING BUSINESS REPRESENTATIVE, DISTRICT LODGE 166, INTERNATIONAL ASSOCIATION OF MACHINISTS AND AEROSPACE WORKERS

Thank you, Mr. Chairman, and members of this subcommittee for the opportunity to testify before you today. My name is Johnny Walker and I serve as Directing Business Representative for District Lodge 166 of the International Association of Machinists and Aerospace Workers. As the largest union at the Kennedy Space Center, we represent over 2,500 hourly men and women who play a critical role in preparing, launching, and maintaining our Nation's only human launch vehicle, the Space Shuttle. I come before you today to give voice to the growing concerns of our members and the communities they live in regarding the extended gap between the end of the Space Shuttle program and the beginning of the new Ares/Orion manned vehicle systems.

Our members have been involved with the space program at Cape Canaveral since 1955 and have participated in every human launch event. While contractors have come and gone, we have stayed, providing a knowledge-base and skill continuity critical to the safety and success of our Nation's space program.

IAM members function as launch operation technicians, mission schedulers, inspectors, ground support technicians, safety support specialists, test conductor operators, air traffic control specialists, and logistic specialists. Additionally, we are plumbers, pipe fitters, sheet metal workers, welders, industrial electricians, crane operators, as well as heavy equipment, crawler, and support services mechanics and operators. Other support occupations include power generator equipment operators, air conditioning mechanics, linemen, alarm technicians, asbestos abatement/insulators, and excavation permit inspectors. Many of these jobs require a journeyman's license or other certification and are not easily replaceable.

Last March, NASA Administrator Michael Griffin, in testimony before the House Appropriations Committee, stated that he recalled “. . . the damage done to our Nation's space program by the loss of critical expertise in human spaceflight following the cessation of Apollo and then 6 years later the effort to recreate it during the Shuttle era.” I too recall that time: the layoffs, the disruption in human lives, and the devastating impact on our communities. For some it meant losing their homes. For others it meant picking up and moving away in search of dependable work. For those of us who remained, moral suffered as our co-workers, friends, and neighbors left.

When the Shuttle program finally began to move forward, many of the skilled workers, both hourly and salaried, who possessed intimate knowledge of key operations, were gone. NASA contractors were then forced to recruit nationwide and

bring in new people unfamiliar with NASA systems. This was an expensive and time consuming process.

I fear now that NASA will repeat the mistakes of the past. The cessation of the Titan program in 2005 resulted in the layoff of 250 highly skilled employees familiar with complex missile systems. With little hope of future employment at the Kennedy Space Center most left the Cape in search of new work—a possible harbinger of things to come in 2010 when the Shuttle program ends. If nothing changes, I believe that the potential impact from a gap in programs will be even worse than it was in the 1970s because today's workers at the Cape have had more training and possess higher skill levels than those from a generation ago.

NASA has indicated that the staffing levels for the Ares/Orion systems will be dramatically lower than are currently needed for the Space Shuttle program. Employment at the Kennedy Space Center for the Ares/Orion launch systems is projected to drop to approximately 9,500 from the present level of 15,000 employees. However, if the funding levels remain as currently projected, employment levels could be significantly lower. Given these dire scenarios, NASA must answer some critical questions:

- *What will NASA do for the displaced workers?* Will they be offered some form of transition assistance? What type of severance package will they be offered? How long will health care benefits be covered?
- *What is the plan for the workforce that remains?* What will be the schedule for the new work that will be needed for the new Ares/Orion manned vehicle systems? What will be the skill mix for that new work? What new training will be required? How will NASA communicate these changes?
- *Perhaps most importantly, what is being done to bring in new work to prevent layoffs and preserve the skill base at the Kennedy Space Center?* For example, why not utilize the existing personnel and facilities for the manufacture and assembly of the Ares/Orion launch vehicles?

The GAO, in a May 2005 report on workforce issues related to the retirement of the Space Shuttle, stated that NASA should follow what it calls a “human capital management approach” in planning the transition to the Ares/Orion systems. While we concur with the report’s focus on workforce issues, we must strongly insist that this planning process include not only senior NASA and contractor management, but also the participation of front-line hourly and salaried workers and their union representatives. Working together we have a much greater chance of achieving a beneficial transition for workers, our communities, the contractors, and NASA. Such a successful transition will be key to accomplishing NASA’s critical mission.

As China doubles its investment in space exploration, deploys satellite destroying weaponry, and makes plans for a manned lunar expedition, we cannot, as a nation, pretend that we can get by on the cheap with a nickel and dime space effort. It is both a matter of our national defense and global technological leadership that we provide the necessary funds for a vital and productive space program. To that end, we must first begin by fully funding the NASA Authorization Act of 2005 and by making up the funding gap that resulted from the Continuing Resolution for Fiscal Year 2007. It is my understanding that this will require approximately \$1.7 billion, slightly less than what we are spending per week in Iraq.

From the end of the Space Shuttle program in 2010 until the launch of the first manned Orion vehicle, currently projected to be in 2015, the United States will be without a human launch vehicle. For the Nation that first put a man on the Moon to be at the mercy and whims of foreign nations for its human space travel needs is simply unacceptable. We must do better and find the necessary funds to move up the Orion launch date. This will greatly enhance our ability to stabilize the workforce and maintain the critical skill base at the Kennedy Space Center.

Mr. Chairman, I know that I speak for all of the dedicated men and women at the Cape, both hourly and salaried, in thanking you, the Ranking Member, and the members of this subcommittee from both sides of the aisle for your tireless efforts to preserve the preeminence of our Nation’s space program.

I thank you for this opportunity to testify today and look forward to your questions.

Senator BILL NELSON. I want you to know, Mr. Walker, Dr. Griffin, who I think is doing a very good job, I feel that he is personally committed, and I think he would tell you this himself. Obviously there is going to be some loss of employment, because if you are

not launching humans, and you are not launching the vehicle, you need less in terms of workforce.

You can minimize it not only with things that we just talked about, such as the assembly team, but you can minimize it by bringing other projects into the Kennedy Space Center in order to keep, what Mr. McCulley was talking about, a lot of those skill sets tuned up and working so that they are not dispersed and gone. I believe I have that commitment from him. I think he would share that with any of you.

What I am going to do is recess the Committee. I am going to run and vote. And I will get back here just as quick as I can and we will resume. Thank you very much.

[Recess.]

Senator BILL NELSON. Please pardon the interruption, but there was nothing we could do about it. Whenever they say it is a 10-minute vote, well, of course, that is always a 15- or 20-minute vote. So anyway, we are back.

We had gone through some preliminaries. Is there anything anybody wants to offer for the record? Of course, each of your statements will be printed in the record. So we have the value of that. If any of you have any statements you would like to make, I want to give you the opportunity. Otherwise, we will just get right on into some questions.

Mr. Gerstenmaier, bring us up to date on the status of *Atlantis* and STS-117. And how that is going to affect the rest of the manifest.

Mr. GERSTENMAIER. OK. Right now, as we speak, we have a team in Florida that is busily repairing the tank. And I can tell you that this is probably one of the best activities I have ever seen in the human spaceflight area.

We have Lockheed Martin, who manufactures the tank for us and we have United Space Alliance, who does the processing at the Cape. And those two contractor organizations are working together better than I have ever seen two contractor organizations work.

The teaming, and the spirit, and the cooperation of the folks that are working on this tank is phenomenal. They are passing engineering back and forth. They are making progress every day on repairing the tank. And they are doing just a great job.

They have passed data back and forth. They are actually mocking up the spray area in New Orleans, so the technicians can practice spraying in New Orleans. And they will actually go spray some foam on the tank in Florida then to finish it up and complete. We still do not know which tank we will use for STS-117. We are letting the work kind of drive the activity. We are not picking a launch date and then forcing the work to fit into that launch date. We are going to let the work drive the schedule to where it needs to be.

If we need to, we can switch the external tanks. The new tank will be shipping from New Orleans either on Sunday or Monday, or this coming Sunday or next Monday. It will be in Florida several days earlier than we had planned. And, again, the Lockheed team has done a great job of getting that tank ready.

We will make a decision around April 10, like we have talked about before, which tank we will use. We can still potentially make

the May launch window, if we use this tank. If we do not, we will be in the June time-frame.

Either one of those launch windows allows us to fly-out the remaining flights needed for Space Station assembly. It turns out, by the end of 2008, or the first part of 2009, the ripple of this delay will have settled out, and we will be back on track again. So we will still have the same margin we have today to complete any assembly flights. So we do not see this as a big impact to us downstream.

So, again, progress is going extremely well. It is a tribute to this workforce that they understand the work that needs to be done. The engineering staff. The technicians. It is just phenomenal. And that is the same workforce we want to use during this transition period.

Senator BILL NELSON. Will there be some slippage for the rest of 2007?

Mr. GERSTENMAIER. Yes. There will be some slippage through the rest of 2007. And a little bit into 2008. And then by kind of the end of 2008, first part of 2009, that slippage will pretty much have damped out. So you will see the flights move a little bit.

We have a manifest option out there that moves a whole bunch of flights around. That is just a planning manifest. So if you see that on a website somewhere that somebody has posted, it looks like everything in the world has moved. It really has not. This is a planning exercise that we put out to the team to take a look at, to try to find an optimum way to go through this period.

It is a pretty complicated assembly sequence, because it not only relies on the Shuttle being ready to fly, but we need to look at what activity needs to be completed onboard the Space Station. And sometimes the Space Station activities pace the Shuttle flights.

So in some cases, the Shuttle may be ready to fly before the Space Station is ready to receive it. So it is a pretty integrated schedule scenario that is more complicated than we have had in the past. So we put this planning manifest out for folks to look at. So it looks like we are maybe more unstable than we really are, but to treat that as just a planning manifest, and we will have around April 10 or so, maybe April 15, we will have the plan laid out for the remainder of the year.

Senator BILL NELSON. To Mr. McCulley and Mr. Dittmore, how are you going to ensure that you have an experienced and sufficient staff on the Shuttle program, while at the same time, starting to shift over? And, how do you keep them from being distracted from the new program?

Mr. DITTEMORE. It might be a little easier for me than it is for Mike. As I mentioned to you earlier, Senator, our basis for the first stage of the Ares I launch vehicle is basically the reusable solid rocket motors that we build today for Shuttle. Instead of a four segment, it is going to be a five segment motor.

Those decisions by NASA a year or a year-and-a-half ago really kicked off the transition, from my viewpoint. Much of our workforce that manufactures these solid rocket motors will be used for both the four segment and Shuttle motor transition over into the five segment motor for Ares.

In fact, we believe we will save NASA a significant amount of money because of the synergy that will exist and the synergy opportunities between the two programs. So from a manufacturing standpoint, we have laid in plans right now for our suppliers and our direct labor to transition over into the Ares I launch vehicle.

I also think that as NASA develops their test flight program at the end of this decade, that test flight program is planned to bridge the last Shuttle flight, all the way to the first operational flight for the Ares I launch vehicle.

And because of that test flight program, we also believe that we will retain significant numbers of skill-sets that can be applied, not only at the home plant for manufacturing, but also at the Cape, for assembly and launch and recovery operations.

So I think those ingredients or those soft-landing types of activities that NASA has put in place help us tremendously in retaining our skills.

Mr. MCCULLEY. Two years ago I was at this table, and you asked me a very similar question. And Mike Griffin had been at the table, I think, an hour or so before me, and you had asked a similar question. And Mike, in fact—Mr. Li, you would remember this—Mike said that in the follow-up contracts, which we now have on contract, he was going to require us to have a capital management plan or a human capital plan in there.

Since that time—of course, there are now real contracts and real work. And in particular, we are a sub to Lockheed Martin on the Ares vehicle. And we are a sub to ATK on the Ares I. We are doing work on the demo flight. And so there are a number of areas where we are involved in the follow-on programs with folks that are really Shuttle guys, and have been Shuttle guys all along.

In addition, as you are acutely aware in Florida, Steve Kohler now, from Space Florida, the business development group, or economic development group, we are looking at opportunities that are out there that would allow us to fill that gap with, perhaps, other work and other businesses.

We have not done a really good job over the years of sort of bragging outside of this immediate family about our capabilities, either in Houston or in Florida. We are doing more of that now to sort of show the world out there that we can do more.

We have done some concrete things in the company, in our human resources world. Bill Gerstenmaier and his team and my team just recently completed the contract negotiations that takes us out through 2010, with some options. And we put some provisions in there that were very difficult to get through, having to do with a number of provisions that deal with employees and how you manage those employees. That is the capital management plan.

Bill and his team, and our folks, worked extremely well together, and got that on contract, which gives us some of the tools to use to manage through this transition, this gap again.

Mr. Li. Mr. Chairman, I would like to address the civil servant side of things, because I understand these plans that both these two gentlemen have in place make a lot of sense. But I am really worried about the issue that we have not been able to hire some folks for a while.

We have a situation now in the science and engineering workforce, civil servant workforce in NASA. They have an average age of 46 years. And then if you take a look at the next—well, we are talking about people that are very, very young. We need to find ways not only to energize folks coming out of school to want to come work for NASA, but this is also happening at the same time, Mr. Chairman, as you well know, that private industry and other Federal agencies, like Homeland Security, are going to be looking for that type of expertise.

We are talking about expertise in program management, systems engineering, systems integration. So I think that is something on which we need to keep our eye on the ball.

Senator BILL NELSON. Mr. Gerstenmaier, just to nail down points from an previous conversation, right now you are looking, if nothing else changes, at March 2015 for the launch of the Ares/Orion.

Mr. GERSTENMAIER. That is correct.

Senator BILL NELSON. I will speak for Senator Hutchison, who cannot be here. She and I are both going to try to get the funding, as I discussed earlier, and move that date back. For many, many reasons.

Do not think that it is just my parochial hat, which clearly is a hat that I wear. It is also my national hat. Because, as I said, we do not know what the world's politics are going to be like. You have a multi-billion dollar investment up there that we want to utilize as a laboratory, and we have to have access to it.

Speaking of that, tell us about cuts. Why can NASA and the Air Force not help those folks out? They have been trying to get permission, you all extended a contract, you want to take cargo up there, and this is an American vehicle. And then trying to get permission to launch from what is the eastern test range, on one of the abandoned Titan paths.

Why has that been sitting still for two years?

Mr. GERSTENMAIER. I will have to take that for the record. We have worked with them. I do not know the specifics of why it has been sitting there. I can provide an answer to you for the record. But I do not have that directly in front of me.

[The information referred to follows:]

SpaceX Applied to the United States Air Force (USAF) 45th Space Wing regarding use of a launch complex at Cape Canaveral to launch the Falcon 9 vehicle. NASA is not directly involved in the negotiations between SpaceX and USAF. The 45th Space Wing completed its application analysis and provided a recommendation to General Kevin P. Chilton, USAF, Commander, Air Force Space Command.

According to the USAF, on April 18, 2007, Dr. Sega, Under Secretary of the Air Force, and General Chilton recommended that SpaceX be granted a five-year non-exclusive license for SLC-40. Dr. Sega and General Chilton briefed Senator Nelson on April 18, 2007, regarding the recommendation.

But we are supporting them from a development standpoint, and we have provided the \$500 million in funding for them to go through. That is being managed by Scott Horowitz and the Exploration Systems Mission Directorate, where they have certain milestones that they need to make. We have the demonstration flights scheduled. We are doing the planning for where those demonstration flights will occur, and when they occur. We are working with them.

We are also looking for the future follow-on contracts, where we will actually go purchase services to deliver cargo to the Space Station. We are starting that activity, to flow that in. And out of that work would follow the launch pad discussions. I know there has been some discussions about that. I just do not know the specifics. And for the record, we will find out what the holdup has been with the Air Force, or with NASA, or where that sits.

Senator BILL NELSON. Is it not clearly in the interest of the country that we have a vehicle to enable us to get cargo up to the International Space Station, until we get our Orion and Ares ready to go and have a vehicle that would be less expensive to operate.

Mr. GERSTENMAIER. The Commercial Orbital Transportation System is something that we need. It is in our plans. It is the way we try to bridge the first portion of this gap between 2010, 2011, 2012, 2013, and 2014. It is in there. We do not have enough capability to launch the assets.

We need the Space Station. The Commercial Orbital Transportation System is necessary. It is mandatory. We reserved cargo for them to go fly. We put plans together. We have funding in our budget to go do that activity. So we are moving out on all those aspects. And I will get you an answer on the launch pad discussion.

Senator BILL NELSON. They have not proven their system yet, but assuming that they do, the only other way that we have of getting cargo up there, under the present plan, is the Russian Progress vehicle. Is that correct?

Mr. GERSTENMAIER. This year, we are going to launch a European cargo carrying vehicle, called the Automated Transfer Vehicle. It should fly this fall on an Ariane spacecraft. That is another International Partner vehicle. But it can also carry cargo to the crew, as well as water and propellant.

Then in July of 2009, a Japanese H-2 transfer vehicle comes online. Again, that will be able to carry both pressurized cargo, things that fly inside a pressurized volume, as well as external cargo on the outside. And that is scheduled for 2009.

The new Commercial Orbital Transportation Systems, they are coming online. They will use some of the sensors and some of the equipment that are being developed for the Automated Transfer Vehicle and also the H-2 transfer vehicle. So we are getting some commonality of those components, and making them available to the commercial sector, so they can ease their task of them coming up and docking with the Space Station.

Senator BILL NELSON. Have either of those other two vehicles been flight tested and proven?

Mr. GERSTENMAIER. No. They are not flight tested or proven. In fact, the Automated Transfer Vehicle that flies this year, it will dock with the station, but there will be effectively a 16-day checkout before it comes up and docks with the station. During those 16 days, we will do collision avoidance maneuvers with it. We will make sure that it flies the way we anticipated. We will make sure the software works during that kind of checkout period.

You can think of it, as it comes closer and closer to docking, and then we back out, until we gain confidence in that vehicle, then when it passes its final check, like a flight test, then we can take it on into docking.

But at this point, none of those vehicles are proven. They are still in the development cycle. So that tells us that there is a lot of work in front of us of doing this rendezvous prox-ops activity. And that the Automated Transfer Vehicle, the physical hardware has been around for probably more than a year. The physical hardware has been ready.

It has taken a long time to get the software checked out and get it ready to go work. And I think our Commercial Orbital Transportation folks will have that same problem. We may see their hardware ready, but they are not ready from a flight software standpoint. And that may be more of a driver to them than is apparent today.

So we factored some of that into our thinking. But we are really counting on them. And we are going to do what we can to make sure that they are successful.

Senator BILL NELSON. Where does the Japanese vehicle launch from?

Mr. GERSTENMAIER. It launches from Tanegashima, Japan. That is their launch site.

Senator BILL NELSON. It sounds like it is clearly in NASA's interest that you have another competitor that would be able to have access to the Space Station. And if your answer is that the Air Force is holding this up, then we need to have a little prayer session with the Air Force. If you would get back to us, I would appreciate it.

Tell me, Mr. McCulley, in the *Columbia* Accident Investigation Board, they determined that inadequate funding was a contributing factor to that accident. You pointed out that the NASA budget has taken some hits in the past few years, as many of us up here have. And you state, "The Fiscal Year 2008 budget does not reflect the real needs of the agency." Can you elaborate?

Mr. MCCULLEY. Post-*Challenger*, during that—I have had the unfortunate experience of living through a return to flight twice. The funding profile that was provided the agency after *Challenger* included moneys to recognize—that recognized the additional expense associated with return to flight.

After *Columbia*, we took on all this work. We did the same things that we had to do before. Redesign. Rework. Rebuild. And then you had the hurricanes on top of that in 2004 and 2005. And as near as I can tell, as far as I can see, there has not been money put in.

So the agency has been asked to take on this new program, continue to fly safely with the old program. Continue to serve the Space Station. And to do it on essentially what I—from my knowledge, a flat budget.

Now I do not do policy and I do not do budgets. I am an implementer with my customer. But my observation is that they do not have enough money to do what they have been asked to do.

Senator BILL NELSON. To all of you, can the facilities, the technologies, and the personnel, be in place to support an expedited schedule, to move this thing back from March of 2015? What are the long poles in each of your schedules? Mr. Gerstenmaier, why don't you try that?

Mr. GERSTENMAIER. Again, I think in my opening remarks, when asked, I said we would go back and we would look at the critical path, to see where things fit, to see what technology things are there. And we will get you an answer on that.

[The information referred to follows:]

It is not easy to estimate the savings in development costs that would be achieved by accelerating the CEV Initial Operational Capability (IOC). The cost of certain design, development, test, and evaluation (DDT&E) functions depends on how long a project requires those functions, and these additional costs are not insensitive to schedule. NASA's parametric estimates of savings below are based solely on the cost of staff for these functions multiplied by the number of months saved.

Completing development work on all Constellation systems to support IOC earlier than 2015 would avoid DDT&E costs associated with less efficient phasing of development activities and stretching the critical path while sustaining personnel involved in the early development.

Parametrically derived estimates using design data known at this time (one year prior to Preliminary Design Review) indicate that by advancing IOC to 2014 and avoiding these inefficiencies, our net estimated savings would be approximately \$350 million. However, this would require additional funds for development: \$350 million in FY 2009 and an additional \$400 million in FY 2010, for a total of \$750 million.

Advancing IOC to 2013 to avoid these inefficiencies would result in a net savings of approximately \$800 million. However, this would require additional funds for development: \$400 million in FY 2008, and an additional \$1.6 billion spread over FY 2009 to FY 2010, for a total of \$2 billion.

I know one item that stands out is the J2X engine that is on our current critical path. We need to look at that J2X engine development and make sure that by getting additional funds, we can actually pull that back and it fits from an overall standpoint. But that is one item that I can say today that we will look at.

But we will take it for the record to go look and see if there are any other items that sit out there, that are sitting just behind J2X and the critical path that we would want to talk about.

From a facilities standpoint, I think we are in pretty good shape overall. We still have some pad stuff that we need to watch. We have to keep one launch pad around to keep a rescue Shuttle available for the Hubble repair mission. So we were unable to turn that launch pad over to Constellation as early as we would like. We need to keep that launch pad in a Shuttle-ready configuration, to launch a contingency flight, if required for the Hubble mission.

So we have a little bit of extra work there to do with Constellation. I do not see that as a showstopper. It could potentially impact the test flight, the first Ares four-segment test flight that we had planned. But we will watch that.

From a personnel standpoint, I think we have the resources to go on that. We have enabled some of our workforce, as Mike McCulley talked about, to actually begin working on some of these new activities. So they essentially have two charge codes. Which is very good.

So they can begin working on some of the new activities. Then if we have a Shuttle problem, we still have the ability to grab that workforce back to pull them back, to help us with that. So I think from a workforce standpoint, we have a pretty solid and robust plan.

Senator BILL NELSON. Mr. Karas, what are the long poles in your tent?

Mr. KARAS. Well, first of all, Mr. Chairman, I think Mr. Gerstenmaier and the NASA team have done a great job. We have some excellent facilities, as you know, out of Florida, and the O&C, and activities at the Cape. So I think that is good.

The personnel we are getting, because we are transitioning now, are good. I think technology-wise, in our systems, we bid very high, you know, technology readiness levels in CEV. So I do not worry about that as much as integration and systems engineering issues.

For example, our number one risk on the critical path is the launch-abort system. And you may ask, "Well, that is a smaller rocket. How does that drive you?" Well, we have some very difficult but, good safety requirements to meet, which drive the size of that vehicle and the launch-abort system, which in turn drives the environment and the qualification testing. And the next thing you know, you are up against schedule. So it is those kinds of issues that we have to work through.

So I do not see any real technology drivers, other than human spaceflight is challenging and noble work. And there are a lot of things that we have to go do. And I think you end up with a schedule driven by integration and test.

Of course, on the other hand, we would all like to see the gap minimized. But on the other hand, we cannot rush human spaceflight, and we want to get all the tests right. So it is really all about the continuity of the workforce and maintaining the workforce—not making the gap any bigger, but making sure that those people are available, and the integration is done as early as possible.

Senator BILL NELSON. Mr. Walker, do you think we understand the impact of the transition on NASA and the contractor workforce during that gap?

Mr. WALKER. The main thing I want to comment on is that beyond a shadow of a doubt, the talent is there. No doubt about it. I think the aspects of the unknown at this point in time, not having a surefire plan to where we are heading, or it being presented to the launch team, or the, you know, folks at the Cape.

I think the uncertainty, we need to make sure the morale is where it needs to be, as far as the personnel goes. I think those are the—you know, coming from us, from the employees themselves, I think that is the main concern that is on their mind at this point in time.

I just also wanted to comment, not trying to change the subject, but comment at this point in time about relying on foreign countries for our program. This program has been part of this Nation. It has been the heart of this, as far as I am concerned. I have been in this program since—about 29, 30 years.

The people out there are very proud of it. But I just really find it difficult that we are relying on foreign folks to put our program in place for us. I think it is our responsibility to do that.

Senator BILL NELSON. Amen. Let us talk about the Space Station during this gap period. Other than, Mr. Gerstenmaier, what you have already shared with us with regard to the logistics, and some of the vehicles that you talked about, with regard to crew rotation, is there anything else we should know about how you keep operations going on the ISS during the gap?

Mr. GERSTENMAIER. I think the only thing I would add is that we have done quite a bit of work at looking at what happens when the Shuttle goes away. Because our original plan for the Space Station was to essentially bring spares down from the Space Station, repair them in the depot, and then take that spare component back up to the Space Station.

When we lose the Shuttle, we lose the ability to return large amounts of cargo to the ground. So we are in the process now of redesigning that sparing philosophy, where it is more of a disposable sparing philosophy.

So as a component fails, we will just fly a new one up from the ground. So we are going to have to reestablish some new supply lines to get that sparing in place.

We are doing that, looking forward to exploration. So if we have to build a new electronics box, we are trying to look at, could we do something in combination with the exploration group that they are going to need. So we do not build a unique replacement for a station that is not consistent with what exploration needs.

That also allows us to check that hardware out, essentially, and test it on orbit, and make sure it works in the space environment before exploration needs it. So we are kind of going through kind of component by component, seeing what we can do to help get a synergy between what exploration needs and what we need to replace to help with that supply line that goes forward.

Mr. LI. Mr. Chairman, one of the issues on the Space Station that many folks have been talking about is, if 2010—and it is the date at which we will retire the fleet. There are two flights in 2010. The last two flights are, in essence, bringing up pre-positioning spares.

If those flights do not come to fruition, that will have severe consequences on what the life of the station will be. And, therefore, the research that we are going to be able to conduct will be curtailed. And that is a very important point to raise.

Senator BILL NELSON. It is. And thank you for raising it.

Mr. Gerstenmaier, let me ask you, setting aside the cuts, what do you see in the progress—the Japanese HTV and the European ATV? What percentage of the cargo, during the gap, would be carried up by each of those?

Mr. GERSTENMAIER. The way we have allocated it now is it is on a yearly basis. On a yearly basis—we are in the process of procuring in 2010, 4.2 metric tons of cargo from the Russians, to be carried on a series of Progress vehicles throughout that year. That does not all come up on one vehicle. It gets spread on several Progress vehicles throughout that year.

In that same year, 2010, we have 4.9 metric tons available for the Commercial Orbital Transportation System. So we have more cargo available to be carried by our commercial system than we have given to the partners, in that respect, by the 4.2 versus the 4.9.

As part of their commitment to the Space Station, both the Europeans and the Japanese provide us these launch vehicles. So the Automated Transfer Vehicle and the HTV vehicle, those are their payment in kind for us launching their modules to orbit and operating them on orbit.

So we are not purchasing those services from either the Europeans or from the Japanese. Those are provided to us as part of the basic agreement of the Space Station. We will have basically one of those vehicles each year. We will have one ATV vehicle and one HTV vehicle per year during that time-frame. But, again, we are not purchasing those. Those are part of their commitment for us providing the launch of their modules and operations of their modules.

So the difference is, as you go back to the numbers, 4.2 versus 4.9. So we have basically more cargo available for the Commercial Orbital Transportation System than we do for what we are purchasing from the Russians in the initial phase.

Senator BILL NELSON. How much are we going to pay the Russians for those vehicles?

Mr. GERSTENMAIER. For now—

Senator BILL NELSON. During that period of what you have planned now as the gap, 2010 to 2015.

Mr. GERSTENMAIER. We are only permitted now to purchase Russian vehicles through December 2011. We have legislation that does not allow us to purchase Russian vehicles beyond January 1, 2012. So between now and 2011, we have—we have purchased transportation, habitation, and the cargo services. The value of all that contracting is about \$700 million.

Senator BILL NELSON. Is that for the period of time from 2010 to 2011?

Mr. GERSTENMAIER. It actually goes back to 2009 through 2011. That period.

Senator BILL NELSON. I am trying to figure out what it is going to cost during the gap.

Mr. Gerstenmaier, by accelerating the IOC date, considerable savings could be achieved in the overall life-cycle costs of the Constellation program. How much savings could be gained by moving the launch up? My question is for 2014, from March of 2015. And then I am going to ask you for 2013.

Mr. GERSTENMAIER. OK. For the 2013 answer, that one is similar to the one you asked before. We would like to take that one for the record, because it may be more than just a funding issue. We need to go look at the hardware pieces, and make sure that there is not some other thing that sticks out there that causes a problem that no matter how much money we get, it may not be physically possible to move up to 2013. We do not think so, but we want to go confirm that, so we need some time to go work that.

For the 2014 answer, to move the 6-months forward, the development savings is about \$1.1 billion. Then the costs to do that would be \$750 million. To advance it from, essentially, March, up into September. So a net savings of \$350 million, from just a development standpoint. And that is from 2015, to September 2014.

Senator BILL NELSON. So a net of \$350 million is what you save.

Mr. GERSTENMAIER. In development.

Senator BILL NELSON. All right. When you factor in what you would save on the purchase of Russian vehicles, is all that calculated in there?

Mr. GERSTENMAIER. That is not calculated in there. We need to go look at that. Because, again, there will be some costs associated

with flying CEV, from an operational standpoint, that will offset some of the savings that we gain by not having to pay for the Russian vehicles. And we need to go do that calculation.

Senator BILL NELSON. Well, that was the question I asked of Dr. Griffin. And I wanted to get all that on the table, so that we are talking apples to apples. If we move it back two years by spending more money now in the development cycle what is it going to end up saving us down the line? Not even to speak of lessening our reliability on all these foreign systems.

I thought you all were going to be prepared to give us that answer today. So when could we expect that?

Mr. GERSTENMAIER. We can get you an answer in 2 weeks.

[The information referred to follows:]

Compared to existing Russian assets, the Commercial Orbital Transportation Services (COTS) program is intended to result in more affordable, U.S. crew and cargo delivery capability to the International Space Station. If U.S. commercial services are unavailable or unaffordable post-Shuttle retirement in 2010, services from Russia, other International Partners, and the Orion/Ares I vehicle would be used. The estimated marginal cost of an Orion/Ares I flight is approximately \$40 million per seat, while a seat on a Soyuz flight in 2014 is expected to cost approximately \$37 million based on inflating the currently contracted seat cost. While this price difference is negligible, NASA believes national priorities rather than comparative costs between Soyuz and Orion drive the decision both to pursue COTS and to prevent further slippage of the Orion/Ares I IOC. A shorter transition from Shuttle to a new U.S. spaceflight capability will also meet U.S. policy objectives spelled out in the Vision for Space Exploration and the NASA Authorization Act of 2005 (Pub. L. 109-155).

Senator NELSON. All right. We will have another hearing at some point in the future, so we can get all of that out on the table. You obviously see where I am going. I would not like to have to pay Russia for access to space. Not even to speak of all the uncertainties there. And at the same time, cut American jobs, and cut all that expertise, and all that corporate memory.

Let us go on to something else. Achieving an on-time launch of an Ares/Orion system will depend, in large part, on all of these technical programmatic issues and financial management. Mr. Li, I am going to ask you this.

The Government Accountability Office released a report last year critical of NASA's acquisition strategy for the Orion vehicle. I understand that NASA has since made some changes in the Orion contract. Would you bring us up to date on that status?

Mr. LI. Certainly, sir. Thank you for that question. The issue that we had a disagreement about related to the fact that NASA wanted to write a contract and provide that contract to go all the way through production and sustainment.

We disagreed with that approach, and felt that they had insufficient knowledge to be able to make that commitment for the country. As a result of some discussions that we had subsequent to our report, NASA changed their acquisition strategy, and instead of having one single contract, had one contract with the development and test, and put production and sustainment as options. They will wait until they have further information, until they will write those contracts for what they call schedule B and C.

We are still concerned, however, Mr. Chairman, about the fact that they have gone a little bit farther than we would like, because we do not think they have the knowledge. And that particular

knowledge, there has been discussion about the fact, is the business case that GAO is talking about.

When we talk about a business case, we are talking about an issue where the requirements are well understood. We are talking about a situation where there are good cost estimates. And we are talking about where technology is mature.

The issue that—and Mr. Karas mentioned this in terms of technology readiness levels. This is a unit of measure that actually NASA has developed and now is also being used by the Department of Defense.

The issue is not only the maturity of individual components or subsystems. The issue is the integration of those particular systems. That is where things fall flat. In terms of cost, that is also an area where—when we have cost overruns, that has been an area where that has shown up.

Senator BILL NELSON. Mr. Gerstenmaier and Mr. Karas, do you want to comment on that?

Mr. KARAS. Yes, sir, Mr. Chairman. Well, I think since before the phase one CEV contract finished and before CEV proposals went in, I think, at least from a contractor standpoint, we worked really hard on, I will say our cost estimating and our technology maturity.

And since then, we have had at least one or two design cycles, two design cycles, with NASA, at JSC, and I believe that our requirements are maturing. We have had a System Requirements Review (SRR), and have closed another design cycle. And we are rolling all those into new cost estimates.

So I think our design maturity level is increasing. I think that we have a really good set of cost estimates, a good plan, that we are working on. And I agree with Mr. Li when he talks about integration. And I think any large program of this magnitude has those things to work through.

I think we have an excellent partnership with NASA, with what we are working on. And the fact that we have collocated with NASA in our work, not only in Florida, for final assembly, but in Texas, as far as the engineering, to work side by side with NASA to try to mitigate those issues.

I think we are off to a great start. And, of course, every year we have to earn our stripes and our wings. And I think, if anything, the requirements and cost estimates are maturing and getting better all the time.

So I think those are things that we always have to worry about with guarded optimism, but I think the situation is as good as I have seen in any NASA program that I have been associated with.

Mr. GERSTENMAIER. I do not think there is anything that I would add specifically. Scott Horowitz manages the Exploration Systems Mission Directorate, and he follows this activity a lot closer than myself. So I would ask if Scott has anything that he would like to add, that he could mention that now. Scott?

**STATEMENT OF SCOTT J. HOROWITZ,
ASSOCIATE ADMINISTRATOR, EXPLORATION SYSTEMS,
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

Mr. HOROWITZ. Thanks. Yes, sir. As Mr. Li mentions, you know, we always worry about requirements stability. If you want a program to succeed in your requirements stability, use known technologies, and have stability in budget and programming.

When we worked through the initial design of Orion, we had two internal NASA designs that flesh out the requirements of the mainstream team and then a smart buyer team. We also had two contractor teams competing for the design.

And one of the things that gives you a really good feel that you knew your high-level requirements—though they have not changed, four people to the Moon, six people to the station. If you laid all four models from all four teams on the table, to the untrained observer, you could hardly tell a difference. I mean the biggest change we have had in over a year to the vehicle is that the size changed about half a meter. That is the biggest change we have had.

So we have a lot of stability at the high level. We are working as a team. We had advanced the design as far as NASA could advance it on their own. We had to get a contractor onboard to take the best ideas of the contractor world, the best ideas of NASA, form a team to go solve all these engineering problems that are being discussed. So it is not a technology problem. It is really a group of people working together doing good systems engineering. Thank you for your time.

Senator BILL NELSON. Yes, sir. Anything else that any of you all would like to bring before the Committee? I am going to submit some questions for the record on behalf of Senator Hutchison. And if you all could respond to them. Is there anything else you want to bring up? Mr. Walker?

Mr. WALKER. Yes. I just wanted to make a couple of last comments. During the Titan fly-out, when the Titan program flew out, we had contingencies to keep the talent in place until the end of mission. There is a GAO report out about the management, the capital management program. And I just wanted to make sure that there is consideration given to the front-line hourly and salaried individuals, that they would be included in that.

If we are going to cut back, and it appears to me we are, how do we take care of those folks who have dedicated their lives to these programs? I think it is fair and it is just.

The other comment I wanted to make is, I also serve on Space Board Florida, trying to bring in more commercial business to help supplement some of these cutbacks that we are going to do. During those discussions that we had, range safety was an issue brought up. That we had to somehow streamline or get rid of the red tape in some way, shape up range safety.

So that process, I believe, is currently going on, as far as Space Florida is concerned. But yes, it is certainly a problem that stands in our way of bringing in commercial—and being competitive in that nature.

Senator BILL NELSON. And that has been going on for years.

Mr. WALKER. Yes, sir.

Senator BILL NELSON. Your concerns about the workforce are certainly acknowledged and shared. The ideal is to have as little disruption of that workforce as is possible, that is, otherwise, not taken by normal retirements. And I said "normal retirements."

I want to get all these answers out on the table, as we are going ahead. In the meantime, let me implore you. Senator Hutchison and I cannot do this by ourselves. There are key additional Senators and we are going to need to have their help. And every one of you sitting at that table has a relationship with those Senators.

I would appreciate it very much if you would give them the value of your knowledge and your opinion, and if you would do that personally with those Senators. This is a pretty important deal to the future of the civilian space program. I would appreciate it very much if you would make it a point, each one of you, to do that.

Thank you very much. If there is no further business, the meeting will stand adjourned.

[Whereupon, at 4:43 p.m., the hearing was adjourned.]

A P P E N D I X

PREPARED STATEMENT OF HON. KAY BAILEY HUTCHISON, U.S. SENATOR FROM TEXAS

I want to thank you Mr. Chairman, for convening this extremely important hearing, and I join you in welcoming our very distinguished panel.

I firmly believe that successfully making the transition from the Space Shuttle to the next generation of U.S. human spaceflight is vital to the economic well-being and security of our Nation.

I want to emphasize my reference to "United States human spaceflight," because we are in an era where the ability to launch humans into space is no longer limited to just the United States and Russia.

Already, China has joined that exclusive group of nations, and others, such as India and the European Space Agency, are actively exploring the development of independent human spaceflight capabilities. Still other nations are expressing interest in doing so.

In an age of increasing global technological competitiveness, these are significant developments, and they require the United States to be aggressive and vigilant if we are going to maintain our long-standing leadership in the area of human spaceflight.

I know that both of us, Mr. Chairman, remain very concerned about the gap between the retirement of the Space Shuttle and its replacement with the Ares I launch vehicle and the Orion crew spacecraft.

We have been told by NASA that, to a very great extent, the closing of this gap is a matter of current funding levels, and the confidence in future funding levels. I am committed, as I know you are, to trying to address both of those concerns, and in seeking Administration agreement and support to do so.

I am delighted that we have a panel of witnesses today who are squarely at the pointed edge of the spear of ensuring U.S. human access to space. I hope they will be able to tell us what specific things we need to be aware of to ensure we do not take any missteps in moving forward, and I look forward to receiving their statements and hearing their responses to our questions.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. DANIEL K. INOUE TO
WILLIAM H. GERSTENMAIER

Question 1. What are the savings in development costs by accelerating IOC to 2014? To 2013?

Answer. It is not easy to estimate the savings in development costs that would be achieved by accelerating the CEV Initial Operational Capability (IOC). The cost of certain design, development, test, and evaluation (DDT&E) functions depends on how long a project requires those functions, and these additional costs are not insensitive to schedule. NASA's parametric estimates of savings below are based solely on the cost of staff for these functions multiplied by the number of months saved.

Completing development work on all Constellation systems to support IOC earlier than 2015 would avoid DDT&E costs associated with less efficient phasing of development activities and stretching the critical path while sustaining personnel involved in the early development.

Parametrically derived estimates using design data known at this time (one year prior to Preliminary Design Review) indicate that by advancing IOC to 2014 and avoiding these inefficiencies, our net estimated savings would be approximately \$350 million. However, this would require additional funds for development: \$350 million in FY 2009 and an additional \$400 million in FY 2010, for a total of \$750 million.

Advancing IOC to 2013 to avoid these inefficiencies would result in a net savings of approximately \$800 million. However, this would require additional funds for development: \$400 million in FY 2008, and an additional \$1.6 billion spread over FY 2009 to FY 2010, for a total of \$2 billion.

Question 2. What savings, if any, would we realize by not having to use Russian assets?

Answer. Compared to existing Russian assets, the Commercial Orbital Transportation Services (COTS) program is intended to result in more affordable, U.S. crew and cargo delivery capability to the International Space Station. If U.S. commercial services are unavailable or unaffordable, post-Shuttle retirement in 2010, services from Russia, other International Partners, and the Orion/Ares I vehicle would be used. The estimated marginal cost of an Orion/Ares I flight is approximately \$40 million per seat, while a seat on a Soyuz flight in 2014 is expected to cost approximately \$37 million based on inflating the currently contracted seat cost. While this price difference is negligible, NASA believes national priorities rather than comparative costs between Soyuz and Orion drive the decision both to pursue COTS and to prevent further slippage of the Orion/Ares I IOC. A shorter transition from Shuttle to a new U.S. spaceflight capability will also meet U.S. policy objectives spelled out in the Vision for Space Exploration and the NASA Authorization Act of 2005 (P.L. 109–155).

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO
WILLIAM H. GERSTENMAIER

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RESPONSES TO WRITTEN QUESTIONS SUBMITTED BY HON. KAY BAILEY HUTCHISON TO
WILLIAM H. GERSTENMAIER

Question 1. Assuming you can avoid more severe hailstorms or other weather-related damage, how confident are you that the remaining Shuttle manifest can be completed before September of 2010?

Answer. NASA launched the Space Shuttle *Atlantis* STS-117 mission to the International Space Station on June 8, 2007. STS-118 is currently scheduled for launch on August 7, 2008. *Endeavour* rolled out of the Orbiter Processing Facility to be mated to the external tank on July 2, 2008. By the end of 2008 or the first part of 2009, the ripple in the manifest caused by the delay of this launch due to hail damage should have settled out, and NASA should be back on track to complete the manifest by the end of FY 2010. The Agency should still have the same margin as today to complete any assembly flights and the Hubble servicing mission.

Question 2. If, for whatever reason, you have not completed that manifest by September of 2010, how will you ensure that the ISS will be completed, as mandated by the Vision for Exploration—and the NASA Authorization Act of 2005?

Answer. The Shuttle manifest calls for 13 assembly flights to the International Space Station (ISS) and one to service the Hubble Space Telescope. In addition, NASA may fly up to two additional ISS logistics flights if they are deemed necessary and can be flown before the end of 2010. There is sufficient schedule margin in 2010 such that, if a flight had to slip out of 2008 or 2009, it could still be flown before September 2010. If there is an unforeseen event that leads to insufficient schedule margin remaining in which to conduct any planned missions, NASA will discuss the impacts with the International Partners and develop a revised transportation plan. NASA has no plans to fly the Shuttle after 2010, and indeed the Shuttle cannot fly after 2010 without causing major disruptions to the Exploration Program. Major contracts and subcontracts are being terminated which make the option of flying additional flights impractical. The basic assembly sequence is ordered in a manner that flies the technically required flights first and then flies the International Partner elements in the order negotiated with all Partners. The last flights, including Node 3, are important for the long-term health of ISS, but could be dropped if no other alternatives exist.

Question 3. You do not yet have the Ares I Upper Stage under contract, as you have indicated. What are the major schedule drivers expected to be in that development? What are the prospects for accelerating that development beyond what you currently envision?

Answer. The Upper Stage Production Request for Proposal (RFP) issued on February 23, 2007, invited companies to bid on the work, which includes helping NASA with design and then fabricating, assembling, inspecting and delivering an integrated upper stage. Final assembly will be at NASA's Michoud Assembly Facility in New Orleans. Proposals had to be submitted by April 13, 2007, and NASA expects to award a contract at the end of August 2007. The winner of this competitive solicitation will work alongside a NASA team that is currently designing the upper stage. The NASA Upper Stage Design team has been working since November 2005, and will continue to lead design and integration work after the production contract is awarded for the upper stage.

The NASA Upper Stage Design team's first priority is to take the necessary time to properly and thoroughly develop requirements for the upper stage design. The Design team held their System Requirements Review on April 3, 2007, which verified that all requirements were accurately defined and allocated down to the various subsystems of the upper stage.

The major schedule drivers for the development of the upper stage include the definition of the manufacturing and inspection process for the common bulkhead design of the tanks, as well as the development of long-lead components. The Design team is aggressively defining risk mitigation plans for the common bulkhead manufacturing process in order to preserve the current development schedule. In addition, the Design team is trying to expedite the design and development phase by initiating early development activities for selected long-lead components, such as Main Propulsion System Pre-Valve, Roll Control System Thrusters, and selected structural components. The next step is to test the early-developed test components to anchor the design and analysis models.

Prospects for acceleration of the upper stage development effort will be evaluated after the production contract is awarded at the end of August 2007.

Question 4. In your statement, you pose—and answer—the question of extending Shuttle flights beyond 2010 to close the gap in U.S. human spaceflight. Your answer was two-fold:

- a. It would take \$4 billion a year to continue Shuttle operations, and that money would come from the Constellation development—causing still further delay in Ares I and Orion.
- b. The Space Shuttle is complex and difficult to fly safely.

The first part of your response assumes a level of funding reflected in the current budget run-out. But if it was deemed a sufficiently high priority to close that gap—and the necessary funds were provided to cover its cost, then the remaining reason would be that the Space Shuttle is difficult to fly safely. But we are flying it now, nevertheless. Is it going to be that much harder after 2010?

Answer. There are three problems—in addition to the \$4 billion per year required with flying the Shuttle beyond 2010. First, it is difficult to retain the focus necessary from the workforce to fly safely for multiple years with an uncertain future. Today we know how many flights remain and the time duration. NASA can concentrate the agency's efforts and remain focused for this fixed period. If we go beyond 2010 with an uncertain end, it will be extremely difficult to manage the close-out and fly safely. The second problem with flying beyond 2010 is that the mission no longer requires the unique capabilities of the Shuttle, and no longer justifies the risk of flying a complicated vehicle such as the Shuttle. Prior to 2010, the focus is on assembling the International Space Station and outfitting it for research and sustained operations. This period requires the unique capabilities of the Shuttle and warrants the complexity and risk of Shuttle flights. Beyond 2010, the primary focus would be crew transportation and logistic and scientific resupply. This does not require the unique capabilities of the Shuttle and can be performed simpler, less complicated and with a less expensive transportation systems. Finally, flying the Shuttle past 2010 would cause major disruptions to the Exploration Program, which is planning to use many Shuttle resources.

Question 5. Your statement mentions completing the ISS will fulfill our commitments to our International Partners and “enable us to conduct exploration-focused research onboard.” What about non-exploration-focused research, as required by law?

Answer. Section 204 of the NASA Authorization Act of 2005 (P.L. 109–155) directs the Agency to allocate at least 15 percent of the funds budgeted for International Space Station (ISS) research to ground-based, free-flyer, and ISS life and micro-gravity science research that is not directly related to supporting the human exploration program. NASA is fully complying with this direction as outlined below.

1. *Restoration of Cancelled Grants*—NASA has restored 30 grants in fundamental biological and physical sciences in the areas of Combustion, Fluid physics, Materials science, Cell Science, Animal Science, Cellular biotechnology, Plant biology, and Neuroscience.

2. *Free Flyer Research*—NASA has allocated resources toward domestic and Russian free flyer research participation.

Domestic Free Flyers

- Experiments completed on orbit
 - GeneBox (Bigelow Genesis 1; 7/12/06): A non-deployable Technology Demonstration testing satellite bus and payload technology components of GeneSat-1.
 - GeneSat-1 (Minotaur-1; 12/16/06): Technology Demonstration validating autonomous, in-situ small (nanosatellite-class) spacecraft capabilities to conduct an E. coli growth experiment.
- Approved for flight
 - PharmaSat-1 (Launch ready 10/1/07): Microgravity effect on yeast susceptibility to antifungal drugs in the space environment.
 - 3 MicroSat Flights (2008–2011).

Russian Free Flyers

- Approved for flight
 - Foton M3 (Launch 9/2007): Four NASA sponsored bacteria, snails, geckos and newts Russian collaboration experiments. Follow on experiments for Foton M2 (5/31/05) collaborations.

- Projects being considered for flight
 - Bion M1 (Launch 9/2010): Determine immunological and other effects of lengthy periods of weightlessness on rodents.

3. *ISS Research*—ISS Research has been completed or is planned in Physical and Biological Sciences:

Biological Sciences

- Experiments completed on orbit
 - Leukin (13S; Inc. 13): Effects of spaceflight on the T-cell component of the immune response.
 - FIT (STS-121; Inc. 13): Immune response of *Drosophila* to spaceflight; a model of the human system.
 - TROPI (STS-121 and STS-115; Inc. 13 and 14): Plant responses to light and fractional *g* using ESA's EMCS.
 - Microbe (STS-115; Inc. 13): Virulence of opportunistic pathogens determined following spaceflight.
 - POEMS (Passive Observatories for Experimental Microbial Systems)—(Increments 13 and 14): Mechanisms in the development of virulence, pathogenicity, and anti-microbial resistance in bacteria.
- Approved for Flight (Manifested)
 - SPEGIS (STS-118; Inc. 15): Spaceflight effects on *Streptococcus pneumoniae* gene expression and virulence.
- Under Development
 - APEX—Cambium (Advanced Plant Experiments on Orbit)—Demonstrate remote sensing biometric techniques for stress detection in living organisms.

Physical Sciences

- Experiments completed on orbit
 - BCAT 3 (Binary Colloidal Alloy Test)—(Increment 13): Determine phase separation rates and properties of model critical fluid system.
- Approved for Flight (Manifested)
 - SHERE, hardware (Shear History Extensional Rheology Experiment)—10A (Increment 15): Effect of preshear on the transient evolution of microstructure and viscoelastic tensile stresses for polymer solutions. Samples to be flown on later flight.
 - InSPACE-2 (Investigating the Structures of Paramagnetic Aggregates)—10A (Increment 15): To study the gelation transition in magneto-rheological fluids (MR) under steady and pulsed magnetic fields.
 - BCAT 4 (Binary Colloidal Alloy Test)—1J/A (Increment 16): Determine phase separation rates and properties of model critical fluid system.
 - CSLM-2 (Coarsening in Solid-Liquid Mixtures—2)—15A (Increment 17): Determine the factors controlling the morphology of solid-liquid mixtures during coarsening.
- Projects under development
 - SPICE (Smoke Point in CoFlow Experiment)—Improve the understanding of soot emission from jet flames, by measuring smoke-point properties of jet diffusion flames in a co-flow environment.
 - FLEX-2 (Flame Extinguishment Experiment)—The experiment will assess the effectiveness of fire suppressants in microgravity.
 - CCF, International Agreement with the DLR (Capillary Channel Flow)—Spacecraft fuel tanks that supply gas-free propellant to thrusters directly through capillary vanes.
 - ZBOT (Zero Boil-off Tank Experiment)—Will improve design of long-term cryogenic storage tanks.

In summary, NASA is balancing its portfolio to meet the requirements of the NASA Authorization Act of 2005, pertaining to non-exploration research. In addition, NASA is developing long-range plans to utilize the ISS and free flyers beyond 2010. Non-exploration payloads for ISS will use existing or soon to be delivered science facilities and racks.

Question 6. You indicate that in addition to the 13 remaining ISS assembly flights, there may be two additional ISS logistics flights—"if needed." What deter-

mines whether or not they are needed? What are the planned payloads for those flights?

Answer. The two potential contingency flights to the International Space Station (ISS) would largely carry ISS spares, possibly including: external heat rejection system pump module assemblies (2 units); a fluid hose rotary coupler; a nitrogen tank assembly; the control moment gyroscope for non-propulsive attitude control; a spare special purpose dexterous manipulator arm, a Mobile Transporter/Trailing Uptake System Real Assembly and linear drive unit to support robotic maintenance; a large Space to Ground antenna; a high pressure oxygen gas tank; and nine electrical power components, including six batteries. The need for these contingency flights must be continually assessed based on the sparing needs of ISS, the ability of the Shuttle program to safely fly the mission before 2010, and the availability of alternate carriers capable of carrying some or all of the hardware. These are unique hardware designed to be carried on the Shuttle and, before they can be manifested, careful analysis must be addressed. The planning and ordering of a carrier is also a key consideration. NASA is continuing to look at creative means to provide sparing for ISS.

Question 7. Your statement mentions, on page 4, that “key leaders in the ISS program have transitioned to senior management positions in Exploration.” I was not aware we were trying to attract key leaders away from ISS, which we plan to use—even in your own budget planning—for another 10 years. Can you explain the impact to ISS of those transfers?

Answer. NASA is not trying to attract key leaders away from the International Space Station (ISS) program. Rather, NASA is using its workforce in a manner to best support all Agency programs. This approach benefits NASA and the individuals. It also allows NASA to grow new leaders in the ISS program, which makes for a healthy workforce. Several of the key Constellation program personnel have at one time or another participated in the ISS program. In coordination between the ISS program and the field centers, NASA is actively balancing the personnel needs of the three human spaceflight programs: Space Shuttle, ISS, and Constellation. As a result, the ISS program maintains a broad depth of management, technical and operational expertise within the program and in the supporting organizations.

Question 8. What are the ISS payloads that can only fly on the Space Shuttle, without being greatly modified, that are no longer included in the Shuttle manifest? What key research capabilities or ISS infrastructure will be limited by those deletions?

Answer. The spares identified in response to *Question 6* represent very large orbital replacements units that can currently only be delivered to the International Space Station (ISS) using the unique capabilities of the Space Shuttle. Although these items are not currently included in the Shuttle manifest, they could be delivered on the two potential contingency flights that remain in preliminary planning stage at this time. They could also potentially be carried on future commercial or International Partner vehicles, although it is not yet clear whether these future vehicles will be available or will have the capability to launch all of these spares. In addition, two very large research payloads, the Centrifuge Accommodations Module (CAM) and Alpha Magnetic Spectrometer (AMS) are no longer in the Shuttle manifest. The CAM was originally designed to accommodate research in fundamental biology and has since been determined as non-essential to achieve exploration objectives, while the AMS is designed for research in high-energy particle physics.

RESPONSES TO WRITTEN QUESTIONS SUBMITTED BY HON. MARK PRYOR TO
WILLIAM H. GERSTENMAIER

Enhanced Use Lease Authority

Question 1. Mr. Karas suggests expanding NASA’s enhanced use lease (EUL) authority. The GAO recently recommended that NASA develop an Agency-wide EUL policy and NASA agreed with this recommendation. This Committee looks forward to receiving the EUL policy document. How would expanding NASA’s EUL authority help with the transition from Space Shuttle to Orion?

Answer. Expansion of NASA’s enhanced use lease (EUL) authority facilitates NASA’s ability to realign real property assets with NASA missions. The experience at the two NASA EUL demonstration Centers indicates that EUL has wide potential to support NASA changing facilities needs in support of mission requirements. Expanded EUL authority will support improved performance of NASA infrastructure by positioning the Agency to recover asset values, improve facility conditions, and thereby achieve improved mission effectiveness. EUL will provide flexibility for

the use of underutilized NASA facilities and infrastructure by the contractors and other parties working with NASA to develop Orion and other parts of the Constellation program. The use of EUL will also allow retention of rent revenues for improvement of other NASA facilities including those to be used in the development of Orion.

SpaceX and Rocketplane Kistler—Human Flight Option D

Question 2. NASA is providing seed funding to SpaceX and Rocketplane-Kistler to develop new rockets and spacecraft for logistical support to ISS through the Commercial Orbital Transportation Services. Both companies have proposed an “Option D” to qualify their spacecraft for human flight. NASA has not yet exercised Option D with either company. What are NASA’s plans for exercising Option D?

Answer. NASA has pre-negotiated optional milestones and costs associated with demonstrating a crew transportation capability, Capability D, within each of our Partners’ existing Space Act Agreements (SAA). NASA can exercise this optional demonstration at any time, but does not plan to do so until after a Partner successfully demonstrates a viable orbital cargo transportation system, as defined by completing all cargo transportation milestones defined in each partner’s Space Act Agreements. Any exercise of Capability D would also depend on whether there is money available to cover payment of the negotiated Capability D milestones.

Question 3. Has NASA performed a cost-benefit analysis for Option D?

Answer. NASA has not performed a high fidelity cost-benefit analysis for Capability D. However, NASA has conducted a cost trade (SAA Capability D *versus* no Capability D) to evaluate the impacts to International Space Station crew and cargo transportation budget requirements should Capability D become available.

Question 4. Does NASA think that either company could have a human-rated spacecraft ready by 2010?

Answer. No. As defined in the current Space Act Agreements, SpaceX would conduct their final crew demonstration flight in April 2012, based on a start date of December 2009. Likewise, Rocketplane-Kistler would conduct their final crew demonstration flight in August 2012, based on a start date of January 2009.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARK PRYOR TO
JOHN C. KARAS

Question 1. Last year, Lockheed Martin entered into an agreement with Bigelow Aerospace to study using human-rated Atlas V rockets for space tourism. How long and how much money would it cost for Lockheed Martin to human-rate the Atlas V?

Question 2. Do you think the Atlas V could be used to transport crew to and from the International Space Station?

Question 3. If, yes, do you think that a human-rated Atlas V would be cost competitive with the Orion/Ares launch vehicle?

Answer 1–3. Lockheed Martin is no longer responsible for development of the Atlas V launch vehicle or Atlas V variants. It is recommended that all questions regarding the Atlas V be directed to United Launch Alliance (ULA), a newly formed company that is responsible for development and sales of the Atlas V and Delta IV launch vehicles. Lockheed Martin fully supports NASA in their approach to developing the Ares I Crew Launch Vehicle, leveraging Shuttle technology to effectively address U.S. needs to launch humans to space.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. KAY BAILEY HUTCHISON TO
JOHN C. KARAS

Question 1. Is it correct to say that there are no “technical long poles” in the development of the Orion vehicle as presently designed that would keep you from accelerating development of that vehicle?

Answer. Because the Orion vehicle requires minimal technology development, leveraging recently matured technologies that have been proven in other applications, we do not currently see any “technical long poles.” However, the integration and systems engineering effort in developing a human-rated spacecraft requires compliance with rigorous standards and processes, including a comprehensive test program. Success lies in our diligent management of integration, processes, and coordination. This management task cannot be rushed beyond the reasonably aggressive schedule that NASA has developed. Working closely with NASA and barring

any further erosion of NASA's Exploration budget, we plan to deliver a vehicle in time to meet NASA's schedule for Initial Operating Capability (IOC) in March 2015.

Question 2. What is the earliest that you could deliver the Orion spacecraft, given no budgetary constraints? What would be your estimate of the cost difference to accomplish that, between what you now have planned and what that would require?

Answer. Based on NASA's program formulation and systems assessments addressing all elements necessary for a successful operational launch, including the launch vehicle and ground infrastructure, and based on the reality of budget constraints, the current NASA plan for IOC in March 2015 is reasonable. NASA is responding to questions from your Committee regarding cost differences to accelerate IOC. I respectfully defer to NASA on responses to program cost questions.

Question 3. What is the last possible moment when your Michoud facility would be capable of building a Space Shuttle external tank?

Answer. Critical skills will start to roll off the program beginning in late 2007 and early 2008 as different work stations complete their activities on the last External Tank. Given the production cycle time required to build an ET, authority to build additional tanks must be received in early summer 2007.

Question 4. Your statement speaks about the "pipeline of projects." Can you provide a specific description, from your company's perspective, of the status of the Space Shuttle-related "pipeline," in terms of what is needed to keep it flying? Is that pipeline already running dry?

Answer. The suppliers for ET are being terminated now, so the pipeline is already starting to run dry. Authority would be needed very early this summer to maintain production capability.

Question 5. You mention, perhaps a little facetiously, the value of "Jolt Cola" in carrying forward with our next adventures in space. What kind of "jolt" do you think is needed to ensure that the political and budgetary support is both stable and adequate?

Answer. Due to the gap between retirement of the Shuttle in 2010 and Orion and Ares I operations in early 2015, we will be faced with the challenge of maintaining a highly skilled and experienced workforce. The future of U.S. ability to put humans in space is dependent on our ability to retain our experienced workforce and supplier base and excite the next generation of engineers, scientists, and explorers. I believe it is "jolting" to consider the possibility that the U.S. risks losing our leadership in human spaceflight if we further delay operations of the next generation of human spaceflight systems.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. BILL NELSON TO
JOHNNY WALKER

Question. Mr. Walker, what are your members being told to expect during this transition period? Do we yet understand the impact of the transition on the NASA and contractor workforce?

Answer. While I would not accuse NASA of being dishonest, there are clearly many unanswered questions concerning the transition. Part of this I believe comes from the unknowns regarding the scope of the funding that will be available and the lack of a clearly developed transition plan. Any transition plan must include labor and community representatives, as well as contractors, in its development and implementation. A jointly created communications plan will be a key component of any transition plan.

The types of communication tools could be:

- NASA Television
- Center-wide Face-to-Face
- Defined NASA office with responsibility for interfacing with workforce
- Develop hot line for employee questions

The open and honest sharing of information will allow us to formulate an effective communications plan and to answer the question "what will happen to me?" that so many employees are asking.

If I may be of further assistance please contact me at any time. Thank you for your assistance and support.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. KAY BAILEY HUTCHISON TO
JOHNNY WALKER

Question. In your statement you have expressed concern that the mistakes made in the past regarding sustaining a viable talented workforce may be about to be repeated in this next transition. What are the key steps you believe NASA—and this Congress—should take to avoid that?

Answer. First, Congress needs to adequately fund our space program. This will signal our commitment to a dedicated and skilled workforce that their efforts are understood and valued. The money required to close the gap between the two programs is not significant in the grand scheme of things. It would be my suggestion, as well as others, that the only way to avoid a major impact to working families and our communities, that support our great space program, is to close the gap between the fly-out of the Space Shuttle and the launching of the new Orion and Ares space systems.

I am also deeply concerned to learn that our transition plan requires us to utilize foreign nations, such as, Russia, Japan and European agencies, to supply and to launch manned vehicles (American astronauts) to the Space Station. At a time when supporters of NASA like yourself have to fight for the necessary funding to keep our space program on track, I have ask what kind of support or funding are we to give to foreign nations to provide the services that will be required to keep the Space Station flying? Why not apply those funds to closing the gap between the Shuttle and Orion/Ares programs? Also, we must consider the cost in today's dollar terms versus 4 or 5 years from now.

During the fly-out of the Titan program, in order to keep a stable workforce, and provide a stable transition to new jobs, there was an incentive program put forward to engineering hourly and hourly individuals to stay until fly-out. I would suggest that if we cannot move right into the next program, this should be considered.

During this transition, communications between NASA, contractors, and the workforce must be open, frequent, and honest. The planning process for the transition must include all important stakeholders including union and community representatives. We must jointly identify the key challenges that we will face. Further, we also need to jointly develop and implement the solutions to these challenges. It is impossible to predict all of the problems that we will encounter, but if we work together we will have a much better opportunity to successfully manage a very difficult situation.

I appreciate your concern and your commitment and will offer any assistance that you may need to help us move forward.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. KAY BAILEY HUTCHISON TO
RONALD D. DITTEMORE

Question 1. You have referred to a series of “plateaus” that can mitigate some of the transition challenges we are facing between the Shuttle and Ares/Orion availability. What are the risks you see that would cause those “plateaus” to crumble?

Answer. The “plateaus” that you refer to in the question are what I call “soft landings” where critical skills are required to meet new mission objectives. Additional missions and mission objectives were provided in the post-Apollo era and are also being implemented today. These added objectives or requirements are a very effective method to maintain skill sets onboard as a bridge to the next generation of spaceflight programs.

In the post-Apollo era the Skylab Program and Apollo-Soyuz Test Project served as a bridge to the Space Shuttle. Similarly, an Ares I test flight program is planned that bridges the gap between the last Shuttle flight and the start of Ares I operational capability, utilizing the talents across industry and NASA's field centers. These test flights are absolutely necessary as a part of the Ares I development program but they have the secondary benefit of providing an avenue of transition where critical skills and experience are captured and retained. Additionally, the continued operation of the International Space Station provides the means to retain critical mission management and operations skills at the Johnson Space Center that will be directly applicable to future lunar missions.

The gap between operational programs represents a risk. Any increase in the gap exacerbates transition risks. Increasing the number and frequency of test flights using Ares I hardware and processes can offset a portion of the risk. But it is absolutely clear that an increase in the gap is a significant impact to the manufacturing as well as the operations communities.

Question 2. What is the earliest that you could deliver the Ares I launch vehicle, given no budgetary constraints? What would be your estimate of the cost difference to accomplish that, between what you now have planned and what that would require?

Answer. First, I must point out that since the Ares I Upper Stage and Avionics procurements are still in the competitive phase, I can only speak for the Ares I First Stage—which is under contract to ATK. A more complete answer on the overall Ares I Launch Vehicle and Orion Crew Exploration Vehicle would have to come from NASA.

With that said, we are on schedule to conduct the Ares I–X test flight, utilizing a modified four-segment Space Shuttle Solid Rocket Booster with a fifth segment simulator, in April 2009. Also in April 2009, the first of five ground tests of the Ares I five-segment first stage booster are schedule to begin and continue through 2011. Under the plan that was laid out before the impact of the Continuing Resolution, these ground tests were to lead to three test flights without crews in 2012 and 2013—and the first human flights in 2014. For us to stay on that schedule, we have to assume that there is a satisfactory budgetary solution to account for the Continuing Resolution impact.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. KAY BAILEY HUTCHISON TO
ALLEN LI

Question 1. What role do you believe GAO can play in helping this subcommittee and the Congress monitor and address the challenges you have identified, and other witnesses have identified, in successfully making the transition to the next generation of human spaceflight?

Answer. GAO is well positioned to provide the Subcommittee the insight and foresight to complement the Subcommittee’s oversight responsibilities. We have performed work on NASA for the Congress for many years. Our oversight work has focused on the acquisition and development of space systems, Space Shuttle operations, financial management, human capital and ensuring that NASA complies with applicable laws and regulations, and guarding against fraud, waste, abuse, and mismanagement. Our work also provides important insight on what programs, policies, and questions are working well and what best practices can be shared to achieve successful program outcomes. To assist with the Subcommittee’s oversight responsibilities, we could provide detailed analysis and information on a variety of transition issues facing NASA such as:

- the progress of the development and acquisition of the Orion Crew Exploration Vehicle and the Ares I Launch Vehicle,
- the effect of the retirement of the Space Shuttle on the workforce,
- the Nation’s ability to launch human spaceflight systems in the future,
- monitoring the viability of commercial companies to provide cargo and crew rotation services to the Space Station, and the organizational health of NASA centers.

We would be glad to meet with the Subcommittee to discuss your specific needs, identify work being performed at the request of Congressional Committees, and explore how GAO can be of assistance.

Question 2. In your statement, you mentioned NASA’s agency-wide Strategic Human Capital Plan? What is your assessment of it?

Answer. We are currently reviewing NASA’s ability to attract and retain a skilled workforce for the Senate Committee on Homeland Security and Governmental Affairs, Subcommittee on Oversight of Government Management, the Federal Workforce, and the District of Columbia. As part of our work, we are reviewing the extent to which NASA’s human capital framework is aligned to its strategic mission, outcomes, and programmatic goals. Studies by several organizations, including GAO, have shown that successful organizations in both the public and private sectors use strategic management approaches to prepare their workforces to meet present and future mission requirements. Strategic workforce planning specifically involves systematic assessments of current and future human capital needs and the development of long-term strategies to fill the gaps between an agency’s current and future workforce requirements. When our work is completed, we will be able to update the Subcommittee on our views of NASA’s human capital management.

Question 3. Have you reviewed the Human Spaceflight Transition Plan of July 2006 and the Shuttle Human Capital Plan submitted in April 2006? What is your assessment of these plans?

Answer. As part of our work on assessing how well NASA is positioning itself to effectively manage its supplier base for sustaining the Shuttle and transitioning to the planned exploration activities for the House Committee on Science and Technology, we are examining the Human Spaceflight Transition Plan, and other plans related to the transition. It appears that NASA has in place many processes, procedures, and support systems to carry out this transition, and successful implementation will depend on thoughtful execution and effective oversight. Although these plans provide an overarching strategy for the agency, NASA has not developed a comprehensive cost estimate for retiring the Space Shuttle and the associated transition costs.

Competing demands within the agency, coupled with a declining supply of Federal discretionary funds, means that NASA will undoubtedly be operating in a constrained fiscal environment. Consequently, it is imperative that NASA successfully manage its limited resources in order to achieve successful outcomes. Regarding the Shuttle Human Capital Plan, we are reviewing it and are not in a position to answer your question at this time.

Question 4. With a selected date to retire the Shuttle and begin the gap in U.S. human spaceflight capability, obviously the next key issue is that date at which that gap will end, with the operations of the replacement vehicles. Based on your studies, how confident do you believe we can be in the projected dates for initial Ares I and Orion initial operations?

Answer. NASA maintains a basic assumption that the risks in the development of the Orion Crew Exploration Vehicle and the Ares I Crew Launch Vehicle are minimal due to the use of heritage hardware and low-risk technology. While this assumption seems logical on the surface, in practice, this has not always been the case. Over the past decade, NASA has experienced significant problems with several of its projects that were operating under similar assumptions. Moreover, our work on best practices in system development has found, all too often, that agencies allow programs to proceed without developing key elements of a sound business case. These elements include well-defined requirements, mature technology, a preliminary design, and firm cost estimates. Without such knowledge, NASA cannot predict with any confidence how much the program will cost, what technologies will or will not be available to meet performance expectations, and when the vehicle will be ready for use. NASA has acknowledged that it will not have these elements in place for the Orion Crew Exploration Vehicle until the project's Preliminary Design Review, which is scheduled for Fiscal Year 2008. As part of our ongoing work for the House Committee on Science and Technology, we are evaluating the extent to which NASA's Ares I acquisition strategy incorporates knowledge-based concepts designed to minimize technical and programmatic risk. We are concerned that NASA is using a similar acquisition strategy to that used for Orion. Continued Congressional oversight will be critical for ensuring that these projects stay within cost and schedule goals.

Question 5. You indicate you are reviewing the needs and plans for ISS logistics and maintenance support. What level of onboard research activity are you using as a baseline for this review? Will you be taking into account the possibility of expanded research operations anticipated by implementation of the national laboratory designation of the ISS?

Answer. To evaluate logistics necessary to support ISS research, GAO is reviewing information from a variety of sources, including NASA's Research and Utilization Plan for the International Space Station, ISS User Operations Panel information, ISS Cargo Requirements and Traffic Model summaries, and NASA integrated resupply requirements. Our review should provide the Congress with information on whether NASA's cargo and crew transportation strategy would support or constrain expanded research opportunities for ISS operations as a national laboratory.