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DEPARTMENTS OF VETERANS AFFAIRS AND HOUSING AND URBAN DEVELOPMENT AND INDEPENDENT AGENCIES APPROPRIATIONS FOR FISCAL YEAR 2005

THURSDAY, MARCH 11, 2004

U.S. SENATE,
SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS,
Washington, DC.

The subcommittee met at 10:05 a.m., in room SD–106, Dirksen Senate Office Building, Hon. Christopher S. Bond (chairman) presiding.

Present: Senators Bond, Shelby, Stevens, and Mikulski.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SEAN O'KEEFE, ADMINISTRATOR

OPENING STATEMENT OF SENATOR CHRISTOPHER S. BOND

Senator BOND. Good morning.

This hearing of the Senate VA, HUD, and Independent Agencies Subcommittee will come to order.

Today we welcome NASA Administrator, Sean O'Keefe who is with us today to testify on the President's fiscal year 2005 budget for the National Aeronautics and Space Administration.

Mr. Administrator, it has been quite a roller coaster ride since you joined NASA in December of 2001. We have gone from the tragedy of losing the Columbia, to the uncertainty and perseverance in its aftermath, to the renewed purpose instilled by the Columbia Accident Investigation Board (CAIB) report, and finally the excitement of a Presidential vision for the future that includes returning to the Moon and looking towards sending humans to Mars.

This is an ambitious plan which could generate similar and even greater excitement to that which we are seeing with the current rovers, Spirit and Opportunity, that are working on Mars today.

At the beginning of the year, it looked like NASA was on its way to a budget that would be relatively unchanged. That all changed on January 14 with the announcement by the President about a new vision for NASA which has since translated into a budget request for fiscal year 2005 of over $16 billion, an increase of nearly $900 million from fiscal year 2004. Unfortunately, this impressive increase raises more questions at this time in my mind than excitement.

The Senate fiscal year 2005 Budget Resolution is being debated on the floor as we speak, and the budget numbers contemplated by the President's budget request and in the Senate Budget Resolution currently will mean unacceptable shortfalls for a number of key VA/HUD programs, including VA Medical Care and Section 8 Housing Assistance, as well as the EPA Clean Water State Revolving Fund.

These shortfalls have to be addressed before we provide increases to new programs in other accounts. NASA better hope we get a good 302(b) allocation, above the funding included in the Budget Request. Now, I don't mean to do this to pick on NASA, this is the same message that you will be hearing as I welcome each of the agencies coming before us that administer VA/HUD programs.

The funding for NASA's new Moon/Mars vision is troubling for a number of reasons. As a practical matter, the NASA budget for the fiscal year 2005 through the fiscal year 2009 time period for the Moon/Mars vision is $12.6 billion, of which only $1 billion is in new funds and $11.6 billion is from other NASA activities. Fortunately, many of these activities, such as the Space Launch Initiative, appear to be appropriate sacrifices for the Moon/Mars vision.

However, as part of this redirection of funds, other programs and facilities projects are being deferred, the Hubble telescope is to be retired, and aeronautics spending will remain relatively flat over the next 5 years.

I am sure my colleague from Maryland will have a few things to say about Hubble, but I know that world class science is being done, and can be done, for years to come with this famous telescope, and we should be sure that we are not giving up on it too soon.

I also have joined my colleague in asking for a comprehensive review of the proposed Hubble decision before the implementation of a final decision is made. In the case of aeronautics, we made it clear in the fiscal year 2004 NASA appropriation that we in Congress expected a greater investment by NASA.

It is not an earmark, it is a Congressional investment and Congressional priority. Instead, the fiscal year 2005 budget request proposes $919 million for aeronautics, a reduction of 11 percent from fiscal year 2004. This is a big problem. Europe has declared that they are going to dominate the commercial market in the next decade, yet this technology driven manufacturing industry gets little support from the one agency that can help keep America competitive in this industry.

Given the problems that we are having in the Nation, I don't think this is the time to be cutting back on that investment. It has been those who contended that the Moon/Mars vision is affordable, and at the outset, that could be the case. Yet I am concerned that this new vision will become the next space station, consuming resources as costs begin to rise.

Let me assure you that I have had a little experience dealing with NASA and these costs will go up, and they will go up. Some components of this vision are already in place. Some of the plans for future research on Mars is already underway and can easily be incorporated into the vision, yet the plans for the human vehicle

and heavy lift capabilities that will be needed are just now being placed on the drawing board.

Please forgive me if I question if now is the time to begin the full implementation, or if it would be more prudent to wait a year and let NASA decide what is needed to accomplish the goals set out by the President.

I know the Aldridge Commission was created to provide recommendations for the implementation of the Moon/Mars mission and that these recommendations are due in early June. This will be needed and valuable information, but it will, at best, scratch the surface of what we need to know and only begin to outline some of the challenges we face.

I am especially troubled by the proposed phase-out of the Shuttle and the reduced attention to role of the International Space Station in NASA's mission. We have already spent some $33.5 billion on the ISS, and the redirection of space policy calls into question the value of this investment since the role for the ISS will be severely reduced under the new vision.

In addition, the shuttle is targeted to be decommissioned by 2010, and the next U.S. manned space vehicle, the Crew Exploration Vehicle, is not scheduled for flight until 2014. You will have to go a long way to convince me that a 4-year gap in U.S. manned space flight is sound policy. More importantly, I am convinced that this time schedule is too optimistic, in which case the gap could grow significantly. This raises serious questions as to cost, shuttle recertification, and related shuttle safety issues, as well as obligations to our international partners.

Let me turn now to our international partners. I am gratified that our partners in the international community have responded to the needs of the International Space Station since the Columbia tragedy. The international cooperation has been, and can continue to be, crucial to the success of the endeavors of the space station.

Under the President's vision, we will be completely dependent on other vehicles, most likely Russian, for our human transport to space for at least 4 years starting in 2010. There is a hope that the cooperation we have enjoyed with our partners will continue as we prepare to negotiate the future plans for the space station.

Count me as a skeptic. If we do not maintain a good relationship with our partners to the International Space Station, how can we expect the international community to join in future activities like the proposed missions to the Moon and Mars?

Again, this raises serious questions as to how our obligations to our international partners have changed, how the costs will be borne and what it means for the use and maintenance of the International Space Station. What are they getting for what we're asking from them?

In addition, if the shuttle cannot be certified for a return to flight until next year, what steps has NASA taken to ensure that the Soyuz meets the minimum safety requirements that are now expected for manned space flight since we are trusting our astronauts to these vehicles? Are we demanding the same safety standards that we would demand of the shuttle from the Soyuz? Has this been done? Has this been reviewed?

I understand that there is inherent risk in all of the activities that NASA undertakes, and with that risk comes the possibility for failure or reward. Part of the difficulty involved is in choosing what should be done with limited resources. The problem is that the future budgets for this vision have many points where, if something does not work right, then there will be significant costs to keep us on the path that is being proposed.

There are those who suggest that the private sector may step forward. Well, frankly, the experience of the private sector in trying to work with space has not been good. There have been problems. There have been failures. And I don't see an overwhelming cry in the commercial sector for people to step up and be able to participate in these adventures when past ones have turned out rather sour.

Now, Mr. Administrator, since you took the helm of NASA, I have been impressed consistently with your efforts and commitment to making NASA a better agency. And any concern or criticism I have with regard to the NASA budget is intended as no reflection on the deep regard and the high confidence I have in your leadership. But what really bothers me is I am afraid you are being asked to do too much with too little, in not enough time. And then you have the bad luck of asking for more money for a new program in a time of severe budget constraints.

Nevertheless, we commend your strong leadership and I look forward to working with you in the months to come. NASA is one of the most publicly-recognized agencies within the government. Everyone knows of something that is going on at NASA, be it stunning pictures of the universe, or the surface of a neighboring planet. This high visibility can be powerful in inspiring the future scientists and engineers of this country. We need new engineers and scientists. We need more young people in the United States choosing math, science and engineering curriculums, and I applaud your efforts in keeping NASA exciting and in attracting the young people of this Nation to these careers.

I will have a number of questions on these issues and other concerns that I will either raise today or submit as questions for the record.

Now, it is my pleasure to turn to my colleague, and close working partner, the Senator from Maryland, Senator Mikulski.

STATEMENT OF SENATOR BARBARA A. MIKULSKI

Senator MIKULSKI. Thank you very much, Senator Bond, and good morning, Mr. O'Keefe.

The Committee welcomes you and I know we're going to have a very robust exchange today about a variety of issues.

I so admire NASA because NASA is about discovery, exploration, science and technology. These are fundamental to who we are as a Nation. We are a nation of explorers and discoverers. Human space flight, scientific exploration has been the foundation of our space program for generations.

My goal as the ranking member of this subcommittee is to maintain a balanced space program. That means striking a balance between safe and reliable space transportation, space science and human exploration. I want to congratulate NASA on some of its

most recent successes. Certainly, we're all so pleased with the great job with the Mars rover and the great images we expect to see from your video.

NASA has been able to confirm that water did exist on Mars and we've seen unprecedented photographs of the Martian surface, inspiring the Nation and a new generation of kids in science. I understand the since January 2, there has been more than 8 billion hits on the NASA website on this topic.

And at the same time they have also had an enormous success once again with the Hubble telescope. Hubble is NASA's most successful program since Apollo, and in fact, many say that Hubble is the greatest scientific instrument since the Galileo telescope. Since 1993, Hubble has traveled over a billion miles, taken 330,000 photographs, 25,000 targets, and it accounted, I understand last year, for 40 percent of the NASA's discoveries.

Over there is a picture from Hubble. When you look at it, it looks like a lot of colored dots, but it is a picture of the universe 13,000,000,000 years ago. It is also a picture of the universe with 10,000,000 galaxies, that have been discovered through Hubble. This is a phenomenal achievement.

This extraordinary photograph was made possible thanks to the astronauts and to the space shuttle. We couldn't have Hubble without our astronauts and our space shuttle to make sure that it was launched, fitted with a contact lens, and service it on many occasions. Each time, though, Hubble has been serviced by the astronauts through the shuttle, it has increased Hubble's power by the factor of 10.

There is proposed a fourth and final servicing mission which would extend the life of Hubble. Remember Hubble is not a piece of techno-junk that's creaky, tattered and worn. What it does need though, is like a lot of motors, new batteries and new gyroscopes. And if we put on it the new technology that is waiting to be installed, it would once again improve the factor of Hubble by 10. So extending the life isn't putting Hubble on a respirator, it is giving us a wider view of the origins of the universe.

That's why when I received your call, Mr. Administrator, about the cancelling of the Hubble service mission, I was shocked and surprised. I know that you cited very clearly that you were concerned about the cost of Hubble servicing mission as well as possible danger to the astronauts.

I want you to know that I absolutely agree with you that astronaut safety has to be our highest priority. It has to be our highest priority whether we service the Hubble or whether we complete the space station. We owe it to our astronauts and I believe that's the history of this panel. But at the same time the recommendation to cancel Hubble I viewed as surgery, irrevocable surgery. And I asked you if we could get a second opinion citing that any prudent person when they're facing major surgery that is irrevocable would seek the same.

I want to thank you for your cooperation then to seek that opinion and that's why we turned then, at your request, to Admiral Gehman who chaired the Columbia Accident Investigation Board.

Mr. Chairman, we now have the Gehman letter, and I ask unanimous consent that the Gehman letter be included in the record.

Senator BOND. Without objection.

Senator MIKULSKI. We have the letter here.

Now, what Admiral Gehman says in the letter is no matter what, the use of the shuttle involves risk, whether we go to the station, whether we go to Hubble, whether we do both, that using the shuttle involves risk. He also says, that no matter what mission is undertaken by the astronauts on the shuttle there must be absolute compliance with the full implementation of the CAIB.

This is, I think, a major policy and funding decision that I believe we're ready to commit to today, no matter what we've got to do, to make sure that the CAIB recommendations are fully implemented and fully funded, and I'll be asking you questions along those lines.

At the same time, he then goes into commenting about Hubble. What Admiral Gehman says, is that complying with the CAIB return to flight, and I am quoting now, "NASA has been challenged when factoring in the International Space Station. The CAIB allowed more latitude in complying with their recommendations for non-space station missions.

He then goes on to say, that the Hubble servicing mission may be slightly, slightly more risky taking into account only the debris threat from the orbiter. He also called in his letter for additional study. What he says, then is fully implement, no matter what, the CAIB. Second, that risk is slightly more than other missions.

Then he goes on to say, I suggest only a deep and rich study of the entire gain-risk equation can answer the question of whether an extension of the life of the Hubble. He says the life of the wonderful Hubble telescope is worth the risk. So essentially the Gehman report says slightly more risk and it needs more study.

I really want to thank Admiral Gehman for what he's done both for the Columbia Accident Investigation Board, as well as for this. He is a man of great integrity.

Now, I wholeheartedly concur with the Gehman recommendations. And when he talks about the additional need for more study, I reached out to my colleague, Senator Bond, and am asking you today to cooperate with us for asking the National Academy of Sciences to study the Hubble servicing mission. And also, we will be asking for a study from the General Accounting Office to look at the cost of the servicing mission.

So we have got to be concerned about Hubble. We have got to be concerned about the astronauts, and we have to be concerned about the taxpayer, in order to make a prudent decision.

The National Academy of Sciences, the most prestigious organization of its kind in the world. Its expertise in science and engineering make it uniquely qualified to study risks, mitigation factors, and scientific benefit.

Let's make it clear I will stand up for the Hubble, but I will always place the priority of our astronauts first. At the same time, I want the best minds in science and engineering to tell us what are the risks. And at the same time, look at what it would cost to decommission the Hubble and not use the $167 million worth of instruments.

GEHMAN LETTER

There are a lot of questions to be asked here, and I look forward to engaging in a conversation with you about this, about the NASA priorities as well as the future of our space program. As well as the use of the station, that has been raised by my colleague, as well as the future of the Hubble.

Thank you very much.

[The information follows:]

LETTER FROM HAROLD W. GEHMAN, JR.

MARCH 5, 2004.

The Honorable BARBARA A. MIKULSKI,
Suite 709, Hart Senate Office Bldg., Washington, DC, 20510.

DEAR SENATOR MIKULSKI: In his January 28th letter to you regarding the cancelled servicing mission to the Hubble telescope, NASA Administrator Sean O'Keefe indicated he had asked me to provide to you my views ". . . regarding safety and risk factors identified in the report of the Columbia Accident Investigation Board." from my perspective as Chairman of the Board. The purpose of this letter is to provide you my views on this matter.

I am pleased to undertake this task because it is fully consistent with the goals of the Columbia Accident Investigation Board (CAIB). At the very front of our report, in the "Board Statement", we expressed our belief that:

"The loss of COLUMBIA and her crew represents a turning point, calling for a renewed public policy debate and commitment regarding human space exploration. One of our goals has been to set forth the terms for this debate."

Whether to fly another mission to the Hubble is one of the public policy debates this Nation should have, thus I am pleased to add whatever clarity I can to the terms of the debate.

As you are aware, the CAIB no longer exists; therefore, these views are my own. They are, however, based on the extensive investigation into the Columbia accident. Members of the Board are aware of my efforts, and while the Board is split on the merits of flying this mission, the Board's characterization of the risks as noted in our report are fully agreed. This letter is based on our work and insights gained during the most of careful study of the manned space flight program ever conducted, as well as recent consultations with the Stafford-Covey Return to Flight Task Group and others.

How Risky Are Current Shuttle Flights?

The introduction to Chapter Nine, Implications for the Future of Human Space Flight, is an excellent place to start:

"In this report we have documented numerous indications that NASA's safety performance has been lacking. But even correcting all those shortcomings, it should be understood, will not eliminate risk. All flight entails some measure of risk, and this has been the case since before the days of the Wright Brothers. Furthermore, the risk is not distributed evenly over the course of the flight. It is greater by far at the beginning and end than during the middle.

"This concentration of risk at the endpoints of flight is particularly true for crew-carrying space missions. The Shuttle Program has now suffered two accidents, one just over a minute after takeoff and the other about 16 minutes before landing. The laws of physics make it extraordinarily difficult to reach Earth orbit and return safely. Using existing technology, orbital flight is accomplished only by harnessing a chemical reaction that converts vast amounts of stored energy into speed. There is great risk in placing human beings atop a machine that stores and then burns millions of pounds of dangerous propellants. Equally risky is having humans then ride the machine back to Earth while it dissipates the orbital speed by converting the energy into heat, much like a meteor entering the Earth's atmosphere. No alternative to this pathway to space are available or even on the horizon, so we must set our sights on managing this risky process using the most advanced and versatile techniques at our disposal.

"Because of the dangers of ascent and re-entry, because of the hostility of the space environment, and because we are still relative newcomers to this realm, operation of the Shuttle and indeed all human spaceflight must be viewed as a developmental undertaking. Throughout the COLUMBIA accident investigation, the Board

has commented on the widespread but erroneous perception of the Space Shuttle as somehow comparable to civil or military air transport. They are not comparable; the inherent risks of spaceflight are vastly higher, and our experience level with spaceflight is vastly lower. If Shuttle operations came to be viewed as routine, it was, at least in part, thanks to the skill and dedication of those involved in the program. They have made it look easy, though in fact it never was. The Board urges NASA leadership, the architects of the U.S. space policy, and the American people to adopt a realistic understanding of the risks and rewards of venturing into space."

In other words, for now and for the foreseeable future, by far most of the risk in space flight is in the launch, ascent, entry and landing phases, with a small portion of the total risk associated with the actual on-orbit mission. One could say that, within reasonable bounds, whatever one does once on orbit; it doesn't change the total risk factor very much. The conclusion from this observation, therefore, is to launch the fewest possible number of Shuttle missions. Indeed, the bottom line of the "Future" part of our Report is to replace the Shuttle as soon as possible, and to keep this risk equation in mind when developing the replacement system.

It was one of the CAIB's goals to help national policy makers understand the risks of Shuttle flights by putting space flight as we presently conduct it into context. We as a Nation need to understand, as best we can, the amount of risk we accept while accomplishing our goals of space exploration. In Chapter Five, we quote the 1989 Office of Technology Assessment:

"Shuttle reliability is uncertain, but has been estimated to range between 97 and 99 percent. If the Shuttle reliability is 98 percent, there would be a 50–50 chance of losing an Orbiter with 34 flights . . . The probability of maintaining at least three Orbiters in the Shuttle fleet declines to less than 50 percent after flight 113." (STS–107, the ill-fated Columbia flight, was the 113th Shuttle mission).

And we quote the 1990 Augustine Commission Report:

"And although it is a subject that meets with reluctance to open discussion, and has therefore too often been relegated to silence, the statistical evidence indicates that we are likely to lose another Space Shuttle in the next several years . . . probably before the planned Space Station is completely established on orbit."

To put these very accurate predictions into today's context, we should use figures we know are accurate. We have flown 111 out of 113 Space Shuttle missions safely, for a 98.23 percent reliability rate. The chance that we will be able to fly 25 future missions using this reliability figure without a loss is 64 percent. The more missions we fly, the more that 64 percent number goes down. It is my opinion that implementing all the Return to Flight recommendations made by the CAIB raises the reliability number somewhat, although no one knows for sure what it is. A reliability number more like 99 percent seems reasonable to me, giving a 78 percent chance we will fly the 25 missions without loss. Once again, more missions cause that 78 percent number to go down. Flying one more mission, 26 in all, reduces the probability of series success by about 1 percentage point.

The bottom line: Shuttle flights are dangerous and we should fly the minimum number necessary. Almost all the risk is concentrated in the front and back of the mission, where one goes on orbit makes little difference.

What Can Be Done To Mitigate the Risk?

The recommendations contained in the Columbia Accident Investigation Report pertaining to return to flight are specifically designed to break the coupling or linkage between the propensity of the Shuttle external tank to shed ice and debris and the loss of crew and vehicle. To increase the chances of mission success and decrease the chances that future shedding events, which are inevitable in our view, will result in a catastrophic outcome, four measures are required. The Board feels all four are required; picking and choosing from among the four does not meet our intent.

First, measures must be taken to more fully understand why foam shedding in particular occurs and what steps must be taken to reduce it. This recommendation requires research and development activity as well as some sub-element re-design steps. NASA is well along in implementing this recommendation.

Second, measures must be taken to more fully understand the true strength of the parts of the Orbiter that are most likely to be damaged. The CAIB found, for example, no agreement, backed by test data, on the current strength of the Reinforced Carbon-Carbon wing leading edge components. This recommendation will allow NASA to understand the true nature of the risk to the Orbiter from debris shedding events.

Third, measures must be taken to image the Orbiter both during launch and on-orbit to characterize any hits and to essentially "re-certify" the Orbiter for entry. This recommendation includes much better launch complex camera systems, range imaging systems and an ability to thoroughly inspect the exterior TPS of the Orbiter in space prior to entry.

Fourth, measures must be taken to develop and deploy a capability to make emergency, on-orbit repairs to the TPS to any damage that is deemed threatening to successful entry. This step cannot be accomplished unless steps two and three above are done.

In the view of the Board, all four steps are required, and selecting from among them is not sufficient. While we studied and deliberated these Return to Flight recommendations, it became apparent to us that missions to the ISS had a significant advantage in implementing our recommendations over those that were not going to the ISS. Consequently we decided to differentiate RTF recommendations between missions to the ISS and non-ISS missions. Our report refers only to ISS missions or non-ISS missions. We did not specify what non-ISS missions might be flown (Columbia's final mission was, of course, a non-ISS mission). In our view, missions to the ISS allowed a more complete and robust inspection and repair capability to be developed.

However, knowing that there are situations where docking to the ISS may not occur, we required that ultimately NASA must develop an autonomous on orbit inspection and repair capability. Very frankly, we called for a less technically challenging inspection and repair capability, by stating:

"For non-Station missions, develop a comprehensive autonomous (independent of Station) inspection and repair capability to cover the widest possible range of damage scenarios".

In other words: "Do the best you can". We knew we were essentially REDUCING the requirements. Reducing the rigor of our requirements INCREASES the risk. It cannot be seen any other way. If fully complying with the CAIB RTF technical requirements decreases the risk, complying with lesser requirements must increase the risk. The risk difference is probably not knowable in advance, and knowing the technical capabilities involved the risk difference is probably small, but it is not zero.

It is important to remember the CAIB is talking about risk to the Orbiter from debris shedding events. There are many other factors involved that influence the total risk equation, sometimes very significantly. One of the more significant factors is the heavy cargo loads that are frequently carried to the ISS at high inclinations, which creates risk factors of their own. We did not look at total mission risk and I am not prepared to analyze the total risk equation for all possible Shuttle missions. Further, the CAIB specifically used the generic term "non-ISS" missions to avoid any judgments regarding the relative value of one mission over another.

Bottom line: Complying fully with the CAIB's RTF recommendations is less a challenge when factoring in the ISS. The CAIB allowed more latitude in complying with our recommendations for non-ISS missions, which may be slightly more risky, taking into account only the debris shedding threat to the Orbiter.

Senator, in Chapter Nine of our Report, titled: "Implications for the Future of Human Space Flight", we made the declarative statement that: "It is the view of the Board that the present Shuttle is not inherently unsafe". We were under no pressure to conclude either way on this issue. But I always like to point out that there are two negatives in that quote. We are not saying the Shuttle is "safe", it certainly is not by any common understanding of the word "safe". Nor are we saying it is unsafe and should be abandoned. Our study and report are designed to help NASA manage the substantial risks involved. I suggest only a deep and rich study of the entire gain/risk equation can answer the question of whether an extension of the life of the wonderful Hubble telescope is worth the risks involved, and that is beyond the scope of this letter. What I have attempted to do is offer a very frank review of the risks to all Shuttle operations, Hubble or non-Hubble, as we understand them.

I hope this letter is useful, and as always, I am prepared to answer any questions you or your committee may have.

Very respectfully,

HAROLD W. GEHMAN, JR.,
Admiral, USN (Ret.).

Senator BOND. Thank you, Senator Mikulski.

I appreciate your very thoughtful comments. I now turn to Senator Shelby, our colleague from Alabama.

Senator SHELBY. Mr. Chairman, first I would like to ask that my entire written statement be made part of the record.

Senator BOND. Without objection.

Senator SHELBY. And I will be brief.

STATEMENT OF SENATOR RICHARD C. SHELBY

Senator SHELBY. Mr. Chairman, I want to associate myself with your remarks. I thought you, as chairman of the committee, laid out a lot of our concerns, as well as did the former chairman and now ranking Senator Mikulski. A lot of our concerns and a lot of our questions.

And I had the pleasure, yesterday, of meeting with Mr. O'Keefe. I, like you, hold him in high regard, but there are a lot of serious questions that we've got to probe here. We've got to figure out what we can do, and why we're abandoning—or should we abandon some things that are very important to the future. And I think that Senator Mikulski's idea about dealing with the National Academy of Sciences and getting their opinion on a lot of things is very sound.

Other than that, Mr. Chairman, I am awaiting the remarks of Mr. O'Keefe.

Thank you.

Senator BOND. Thank you very much, Senator Shelby.

Mr. Administrator, please go ahead.

STATEMENT OF ADMINISTRATOR SEAN O'KEEFE

Mr. O'KEEFE. Thank you, Mr. Chairman, members of the Committee. It is a pleasure to be here and I thank you very much for the opportunity to return to very familiar grounds, having served on the Appropriations Committee staff in a prior life. I am always delighted to be back before this forum. If you permit me, sir, I will submit for the record my prepared statement and be very brief in my summary of it.

Senator BOND. Without objection. We will be happy to have your comments.

Mr. O'KEEFE. Thank you, Mr. Chairman.

First and foremost, I think the debate that was launched as the consequence of the CAIB report to establish a national vision, to have a focus and a set of objectives that would be articulated for the Nation's space policy, is an element that certainly after the CAIB report, was engaged in vigorously in all the appropriate oversight committees of Congress, as well as in broader fora within the space community. Those calls for a vision were answered.

The President responded to that. On January 14, he established very firmly, through a long, extensive inter-agency process that involved many other agencies of the Federal Government in addition to NASA, a collaborative position, that he forwarded on that date, that very clearly articulated a new direction, a new focus, and a new strategy for our space exploration objectives.

It is a destiny as explorers as opposed to about a destination. There is a very clear statement that he made that establishes that explorations are our primary focus and objective as opposed to trying to set individual destinations milestones. So when those calls for a vision were made, it was received and that's precisely what he ultimately stated.

Interestingly, the National Academy of Sciences on a different matter entirely endorsed that particular approach in a study they just released here from the National Academy of Sciences and Engineering, through the National Research Council, where it very clearly articulates the proposal of a broader exploration and discovery agenda for the purpose of developing the technologies to achieve those tasks.

In that regard, we're gratified to see the National Academy of Sciences' view that helps us move in the direction of implementing the strategy, I think in very constructive ways. In addition to what we will see from the Aldridge Commission, that as you mentioned, Mr. Chairman, will be convening and devising implementation strategies as well.

Secondly, it is about the Earth. It is about the moon. It's about Mars. It's about beyond. It's one stepping stone at a time. A very specific strategy the President laid out that identifies the approaches on how we would achieve that by degrees and by increments, as opposed by destinations and by, you know, breakneck type of crash programs that have typified the approaches we have taken in the past. That's not what he articulated here.

Indeed, the Mars successes you've referred to in your statements, are one of first steps in that direction, an advanced guard, if you will, that establishes those precursor missions necessary to inform subsequent missions that would follow.

Thirdly, it is about, as he articulated, an impact to all of our lives here on Earth. For every dollar expended for NASA related activities, $7 are spun-off into the economy in a variety of different ways of technology developments that would not have occurred were it not for those approaches. They affect a broad range of things beyond the aerospace and aeronautics community, also a range of medical advances that certainly have benefitted as a result of those activities.

To your point, I think raised by Senator Mikulski, people really care. Eight billion hits to the website in a span of no more than 2 months is a phenomenal testimony to the interest that folks have. It isn't just Mars. About 30 percent of those hits have been to the Mars-related kinds of websites. The other 70 percent is the range of all other activities that we're engaged in. By comparison, all of last year, the websites received hits of 2.8 billion, all of last year. So, this has been a factor of 3-plus over the levels we have already seen, just in the span of 60 days. There is no question that the interest level is high. People care about what we're engaged in, and are excited and inspired by the notion of it.

Finally, it is about, as has been traditionally a nature of the debate, not just about people, or human space flight, or about robotics, it is about both. It's a combination of both efforts. I think Senator Mikulski, you summarized that very well, in one of the stellar successes of how that capability between humans and robotic capabilities, as demonstrated by the Hubble Space Telescope, for example, over the years, some extraordinary achievements in that regard.

It's a precursor or effort, if you will, of establishing how that can be done and set the precedent in so many ways of what the strat-

egy that the President articulated. In this particular case, it would apply for each successive venture that we follow from here on.

Let me just summarize and conclude by asking that the video be keyed-up at this point that articulates what that direction is. It's a short discussion, but it moves through the very specific objectives and agenda of what is involved in this strategy, in words that the President articulated and established on the 14 of January.

If we could.

Mr. Chairman, as the President summarized, it is a journey, not a race and we have designed the budget in order to assure that it is that way. The approach that we have taken to this as illustrated by this one graph, is based on long term affordability, not a balloon payment. Something that progressively builds on successes before we move ahead to the next stage.

PREPARED STATEMENT

And again, I would ask your consent, sir, to insert for the record the National Academy of Sciences' study on these efforts and what these objectives should be, and we will certainly debate the question of how deliberately we are in the process of implementing it.

I thank you, sir.

Senator BOND. It will be accepted for the record, and I thank you very much.

[The statement follows:]

PREPARED STATEMENT OF ADMINISTRATOR SEAN O'KEEFE

Mr. Chairman and Members of the committee, thank you for this opportunity to appear today to discuss NASA's fiscal year 2005 budget request. On January 14th, the President visited NASA Headquarters and announced his Vision for U.S. Space Exploration. In his address, the President presented a vision that is bold and forward-thinking, yet practical and responsible—one that explores answers to long-standing questions of importance to science and society and develops revolutionary technologies and capabilities for the future, while maintaining conscientious stewardship of taxpayer dollars.

The vision forms the basis of the new U.S. space exploration policy, "A Renewed Spirit of Discovery," a copy of which is appended to this testimony as Enclosure 1. This policy is the product of months of extensive and careful deliberation. The importance of these deliberations increased with the findings of the Columbia Accident Investigation Board, which emphasized the importance of setting clear, long-term goals for the Nation's human space flight program. Inputs from Members of Congress informed the administration's deliberations. Many others contributed ideas for the future of the space program. These deliberations were also the basis for formulating the President's fiscal year 2005 budget request for NASA. A commission appointed by the President will advise NASA on specific issues for implementation of the policy's goals within 4 months.

Today, I will summarize the President's fiscal year 2005 budget request for NASA, discuss the goals set forth in the new U.S. space exploration policy, outline the major implementation elements and their associated budget details, explain the implications of this directive for NASA's organization, and describe what the Nation's future in exploration and discovery will look like in the coming years.

FISCAL YEAR 2005 BUDGET SUMMARY

The President's fiscal year 2005 budget request for NASA is $16.244 billion, a 5.6 percent increase over fiscal year 2004, as reflected in Enclosure 2. The NASA budget request is designed with four key principles in mind:

Compelling.—The budget fully supports the Vision for U.S. Space Exploration, and provides for ongoing NASA mission priorities such as Aeronautics and Earth Science.

Affordable.—The budget is fiscally responsible and consistent with the administration's goal of cutting the Federal deficit in half within the next 5 years. NASA's

fiscal year 2005 budget will increase by $1 billion over 5 years, when compared with the President's fiscal year 2004 plan; that is an increase of approximately 5 percent per year over each of the next 3 years and approximately 1 percent for each of the following 2 years.

Achievable.—The budget strategy supporting the vision for sustainable exploration will not require large balloon payments by future Congresses and administrations. Unlike previous major civil space initiatives, this approach is intentionally flexible, with investments in sustainable exploration approaches to maintain affordability. After fiscal year 2009, the budget projects that the exploration vision can be implemented within a NASA budget that keeps pace with inflation.

Focused.—The budget begins the alignment of NASA's program structure with the exploration vision. We now have the needed compass with which to evaluate our programs and make the required tough decisions.

VISION GOALS

The fundamental goal of this new policy is to advance U.S. scientific, security, and economic interests through a robust space exploration program. In support of this goal, NASA will:

—Implement a sustained and affordable human and robotic program to explore the Solar System and beyond;
—Extend human presence across the Solar System, starting with a human return to the Moon by the year 2020, in preparation for the human exploration of Mars and other destinations;
—Develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about destinations for future human exploration; and
—Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.

IMPLEMENTATION ELEMENTS AND BUDGET HIGHLIGHTS

To achieve these goals, NASA will plan and implement an integrated, long-term robotic and human exploration program, structured with measurable milestones and executed on the basis of available resources, accumulated experience, and technology readiness. The policy envisions the following major implementation elements:

Space Shuttle.—NASA will safely return the Space Shuttle to flight as soon as practical, based on the recommendations of the Columbia Accident Investigation Board. The budget includes $4.3 billion for the Space Shuttle, a 9 percent increase above fiscal year 2004. Included in this total is an estimated $238 million for Return to Flight (RTF) activities in fiscal year 2005. The RTF activities are under evaluation to confirm the estimated cost and associated out year phasing. The focus of the Space Shuttle will be finishing assembly of the International Space Station (ISS). With its job done, the Space Shuttle will be phased out when assembly of the ISS is complete, planned for the end of the decade. NASA will determine over the next year how best to address the issues associated with the safe retirement of the Space Shuttle fleet.

International Space Station.—NASA plans to complete assembly of the International Space Station by the end of the decade, including those U.S. components that will ensure our capability to conduct research in support of the new U.S. space exploration goals, as well as those elements planned and provided by foreign partners. The budget provides $1.9 billion for ISS assembly and operations, a 24 percent increase above fiscal year 2004. This increase forward funds $100 million in reserves to partially restore planned near-term reserve levels following the $200 million congressional cut to Space Station in fiscal year 2004 and provides $140 million in new funding for transportation services to the Space Station. We will separate, to the maximum extent practical, crew and cargo transportation for both ISS and exploration missions. NASA will acquire ISS crew transport as required and will acquire cargo transportation as soon as practical and affordable. NASA envisions that commercial and/or foreign capabilities will provide these services.

The administration is also prepared to address issues associated with obtaining foreign transportation services to the Space Station, including provisions of the Iran Nonproliferation Act, but, until the ISS Partnership adopts a specific implementation strategy, it is premature to identify specific issues.

U.S. research activities aboard the ISS will be focused to support the new exploration goals, with an emphasis on understanding how the space environment affects astronaut health and capabilities, and on developing appropriate countermeasures to mitigate health concerns. ISS will also be vital to developing and demonstrating improved life support systems and medical care. Consistent with this focus, the

budget provides $343 million, a 61 percent increase above the fiscal year 2004 request, for bioastronautics research to understand and mitigate risks to humans on exploration missions. Over the next year, the Biological and Physical Research Enterprise will conduct a thorough review of all research activities to ensure that they are fully aligned with and supportive of the new exploration vision.

New Space Transportation Capabilities.—The budget provides $428 million to begin a new Crew Exploration Vehicle, named Project Constellation, which will provide crew transport for exploration missions beyond low-Earth orbit. The current budget planning is based on formulation concept studies to be conducted in fiscal year 2004, preliminary design activities conducted in fiscal year 2005–2006, a System Design Review in fiscal year 2005, and a Preliminary Design Review in fiscal year 2006. NASA plans to develop Project Constellation in a step-by-step approach, with an initial unpiloted test flight as early as 2008, followed by tests of progressively more capable designs that provide an operational human-rated capability no later than 2014. Project Constellation may also provide transportation to the Space Station, but its design will be driven by exploration requirements.

NASA does not plan to pursue new Earth-to-orbit transportation capabilities, except where necessary to support unique exploration needs, such as those that could be met by a heavy lift vehicle. The budget discontinues the Space Launch Initiative, although knowledge gained on the Orbital Space Plane will be transferred to Project Constellation.

Lunar Exploration.—NASA will undertake lunar exploration and demonstration activities to enable the sustained human and robotic exploration of Mars and other destinations in the Solar System. Beginning no later than 2008, NASA plans to launch the first in a series of robotic missions to the Moon to prepare for and support human exploration activities. The budget provides $70 million for these robotic lunar test beds, increasing to $420 million by fiscal year 2009. The policy envisions the first human expedition to the lunar surface as early as 2015, but no later than 2020. These robotic and human missions will further science and demonstrate new approaches, technologies, and systems—including the use of space resources—to support sustained human exploration to Mars and other destinations.

Exploration of Mars.—The stunning images we have received since January 2004 from Mars, and the recent findings by the Opportunity Rover of evidence of water on the Meridiani Planum, lay the foundation of the Vision for U.S. Space Exploration. NASA will enhance the ongoing search for water and evidence of life on Mars by pursuing technologies in this decade to be incorporated into advanced science missions to Mars in the next decade. Also starting in the next decade, NASA will launch a dedicated series of robotic missions to Mars that will demonstrate greatly enhanced capabilities and enable the future human exploration of the Red Planet. The budget provides $691 million for Mars Exploration, a 16 percent increase over fiscal year 2004, and will double Mars Exploration funding by fiscal year 2009. NASA will conduct human expeditions to Mars and other destinations beyond Earth orbit on the basis of available resources, accumulated experience, and technology readiness.

Other Solar System Exploration.—Over the next two decades, NASA will conduct an increasingly capable campaign of robotic exploration across the Solar System. The budget provides $1.2 billion for Solar System Exploration missions to Jupiter's icy moons, to Saturn and its moon Titan, to asteroids and comets, and to other Solar System bodies. These missions will search for potentially habitable environments, evidence of life, and resources, and help us to understand the history of the Solar System.

Extrasolar Planets.—NASA will launch advanced space telescopes that will search for Earth-like planets and habitable environments around other stars. The budget includes $1.1 billion for the Astronomical Search for Origins, a 19 percent increase over fiscal year 2004, to support the recently launched Spitzer Space Telescope, James Webb Space Telescope development, as well as several future observatories. This funding also supports investments to extend the lifetime of the Hubble Space Telescope to the maximum extent possible without a Shuttle servicing mission and to safely deorbit the observatory when its science operations cease.

Enabling Capabilities.—NASA will pursue a number of key capabilities to enable sustainable human and robotic exploration across the Solar System. Among the most important of these capabilities is advanced power and propulsion, and the budget provides $438 million for Project Prometheus to develop these technologies for future robotic and human exploration missions. The budget also includes $636 million in other Human and Robotic Technology funding to pursue sustainable approaches to Solar System exploration, such as reusable and modular systems, prepositioned propellants, space resource utilization, automated systems and robotic networks, and in-space assembly. These technologies and techniques will be dem-

onstrated on the ground, in orbit, and on the Moon beginning in this decade and extending into the next to help inform future exploration decisions. The budget projects that funding for these Human and Robotic Technology investments will grow to $1 billion by fiscal year 2009.

The budget also includes innovative opportunities for U.S. industry, academia, and members of the public to help meet the technical challenges inherent in the new space exploration vision. The budget includes $20 million for the new Centennial Challenges program, which will establish competitions to stimulate innovation in space and aeronautical technologies that can advance the exploration vision and other NASA missions. The budget also provides $10 million for NASA to purchase launch services for its payloads from emerging launch vehicle providers. And as previously mentioned, the budget includes $140 million for Space Station transportation services.

Ongoing Priorities.—The budget supports the Vision for U.S. Space Exploration, while maintaining NASA commitments in other important roles and missions.

NASA continues its commitment to understanding our changing global climate. The budget makes NASA the largest contributor to the interagency Climate Change Science Program with $100 million for the Climate Change Research Initiative. The budget includes $560 million for Earth System Science research, a 7 percent increase above fiscal year 2004, to support research on data from 80 sensors on 18 satellites currently in operation. Work also continues on Earth observation missions in development or formulation, including $141 million (a 36 percent increase from fiscal year 2004) for the National Polar Orbiting Environmental Satellite System Preparatory Project, and $240 million (a 37 percent increase from fiscal year 2004) for missions in formulation, such as the Orbiting Carbon Observatory, Aquarius, and Hydros, as well as the Landsat Data Continuity Mission.

NASA maintains planned Aeronautics Technology investments to improve our Nation's air system. The budget includes: $188 million, a 4 percent increase above fiscal year 2004, for technology to reduce aircraft accidents and improve the security of our Nation's aviation system against terrorist threats; $72 million, an 11 percent increase above fiscal year 2004, for technology to reduce aircraft noise and improve the quality of life for residents living near airports; $209 million for technology to reduce aircraft emissions and improve environmental quality; and $154 million for technologies to increase air system capacity and reduce delays at the Nation's airports.

NASA will continue to make fundamental advances in our knowledge of the Sun and the Universe. The budget provides $746 million for Sun-Earth Connection missions, including the Solar Dynamics Observatory and the Solar-Terrestrial Relations Observatory. The budget also provides $378 million for Structure and Evolution of the Universe missions, including the Chandra X-ray Observatory and three major missions currently under development.

NASA maintains its role in science, engineering and math education. The budget includes $10 million for the newly authorized Science and Technology Scholarship program, which will help attract the Nation's best college students to NASA science and engineering careers. The budget also provides $14 million for the NASA Explorer Schools program, which seeks to attract students to mathematics and science during the critical middle school years. The Explorer Schools program is entering its third phase and will be selecting 50 new schools for a total of 150 participating schools.

NASA's education programs are, and will continue to be imbedded and directly linked to our vision for space exploration. Students now have unprecedented opportunities to engage in NASA flight programs, the observation of distant galaxies, and the robotic exploration of distant planets. Mission experiences link students and classrooms to NASA's diverse personnel, research facilities, telescopes, and planetary probes. Our successful efforts to "inspire the next generation of explorers" sustain a continuous pipeline of scientists, technologists, engineers, mathematicians, and teachers to carry forward our Nation's exploration goals.

Management of Human Capital, Facilities and Institution.—NASA has the distinction of being the only Federal agency to earn top grades for the Human Capital and Budget and Performance Integration initiatives under the President's Management Agenda. Congress recently passed the NASA Flexibility Act of 2004. NASA is grateful for the hard work of this committee in shaping this legislation to provide the necessary flexibilities to better manage the NASA workforce. These flexibilities will be critical to implementing the exploration vision. The budget includes $25 million in fiscal year 2005 to begin to address critical workforce skill and aging issues. NASA ratings have also improved in the Competitive Sourcing and E-Government initiatives, resulting in more total improvements than in any other agency. Although we received a disclaimed opinion on our recent audit statement, we are de-

termined to pursue the right path in Financial Management bringing on a new financial system that will standardize accounting across the Agency and provide the tools necessary for improved program management. NASA remains committed to management excellence and believes it is essential to implementing the new exploration vision.

The budget includes funding for critical institutional capabilities, including $77 million for the NASA Engineering Safety Center and $27 million for our software Independent Verification and Validation facility. The budget also provides $307 million, a $41 million increase versus fiscal year 2004, for facilities maintenance.

ORGANIZING FOR EXPLORATION

To successfully execute the exploration vision, NASA will re-focus its organization, create new offices, align ongoing programs, experiment with new ways of doing business, and tap the great innovative and creative talents of our Nation.

The President has issued an Executive Order establishing a commission of private and public sector experts to advise us on these issues. Pete Aldridge former Undersecretary of Defense and Secretary of the Air Force, is Chair of the Commission. The President has named eight other commissioners to join Mr. Aldridge. The commission will issue its report within 4 months of its first meeting, which was held on February 11, 2004.

Immediately following the President's speech, we established an Exploration Systems Enterprise, which will have the responsibility for developing the Crew Exploration Vehicle and other exploration systems and technologies. Retired U.S. Navy Rear Admiral Craig Steidle, former manager of the Defense Department's Joint Strike Fighter Program, is heading this new organization. Relevant programs of the Aerospace Technology, Space Science, and Space Flight enterprises are being transferred to the Exploration Systems Enterprise. The Aerospace Technology Enterprise has been renamed the Aeronautics Enterprise to reflect its new focus.

As human explorers prepare to join their robotic counterparts, coordination and integration among NASA's diverse efforts will increase. The Exploration Systems Enterprise will work closely with the Space Science Enterprise to use the Moon to demonstrate new approaches, technologies, and systems to support sustained human exploration. NASA's Space Science Enterprise will have the responsibility for implementing early robotic testbeds on the Moon and Mars, and will also demonstrate other key exploration technologies—such as advanced power and communications—in missions to Mars and Jupiter's moons. NASA's Space Science Enterprise will eventually integrate human capabilities into exploration planning for Mars and other destinations.

Many other elements of the NASA organization will be focused to support this new direction. NASA's Biological and Physical Research Enterprise will put much greater emphasis on bioastronautics research to enable the human exploration of other worlds. NASA's Office of the Space Architect will be responsible for integrating the exploration activities of NASA's different Enterprises and for maintaining exploration roadmaps and coordinating high-level requirements.

As we move outward into the Solar System, NASA will look for innovative ideas from the private sector and academia to support activities in Earth orbit and future exploration activities beyond. Many of the technical challenges that NASA will face in the coming years will require innovative solutions. In addition to tapping creative thinking within the NASA organization, we will leverage the ideas and expertise resident in the Nation's universities and industry.

In his speech, the President directed NASA to invite other nations to share in the challenges and opportunities of this new era of exploration and discovery, and he directed us to fulfill our standing international commitments on ISS. We are discussing the impact of our vision implementation plans on the ISS with our partners, and as I have already indicated, we will complete the assembly of the ISS. The President called our future course of exploration "a journey, not a race," and other nations have reacted positively to the Vision; several have already contacted us about joining in this journey. Building on NASA's long history and extensive and close ties with the space and research agencies of other nations, we will actively seek international partners in executing future exploration activities "that support U.S. goals" or "wherever appropriate".

NASA will also invigorate its workforce, focus its facilities, and revitalize its field centers. As exploration activities get underway, NASA anticipates planning, reviews, and changes to align and improve its infrastructure. In order to achieve the exploration vision, we will be making decisions on how to best implement new programs. While some of these necessary actions will be difficult, they are essential to achieving the goals of the overall effort before us. I urge you to consider the full

context of what we will be proposing rather than any isolated, specific action. Such a perspective will allow us to move forward in implementing the vision.

FISCAL YEAR 2003 ACCOMPLISHMENTS

Much of the NASA's future ability to achieve the new space exploration vision is predicated on NASA's many previous accomplishments. The most visible NASA successes over the past year are the Spirit and Opportunity rovers currently on Mars. Already, the landscapes imaged by these twin rovers and their initial science returns are hinting at fundamental advances in our understanding of early environmental conditions on Mars; last week's announcement regarding the discovery of evidence that there was once liquid water on Mars' surface is a dramatic example of such an advance.

However, Spirit and Opportunity are not the only recent NASA mission successes. NASA and its partners successfully launched seven new Space Science missions (including the two Mars rovers), three new Earth Science missions, one new NASA communications relay satellite, and completed two Space Station deployment missions. Operating missions have achieved a number of notable successes, including the Stardust mission's successful flight through the tail of Comet Wild-2, initial images from the recently launched Spitzer Space Telescope, a 10- to 100-fold improvement in Earth's gravity map from the GRACE satellite, the most accurate maps of Earth temperatures to date from the Aqua satellite, and new insights into space weather and solar activity from Sun-Earth Connection missions.

NASA exceeded or met 83 percent of its annual performance goals for fiscal year 2003. Among these accomplishments were demonstrations of new systems to improve air traffic control and to combat aircraft icing, improvements in battery, telescope sensor, and life support technologies; fundamental advances in understanding states of matter (from Space Station research); and the implementation of new remote sensing tools for tracking diseases and wild fires.

THE NATION'S FUTURE IN EXPLORATION AND DISCOVERY

As the President stated in his speech, we are embarking on a journey, not a race. We begin this journey of exploration and discovery knowing that many years of hard work and sustained effort will be required, yet we can look forward to achieving concrete results in the near term. The vision makes the needed decisions to secure long-term U.S. space leadership. It provides an exciting set of major milestones with human and robotic missions. It pursues compelling science and cutting-edge technologies. It invites new ideas and innovations for accomplishing these bold, new endeavors. And it will provide the opportunity for new generations of Americans to explore, innovate, discover, and enrich our Nation in ways unimaginable today. This challenging Vision provides unique opportunities for engaging students across the country, "as only NASA can," to enter careers in science, engineering, technology, and math.

I sincerely appreciate the forum that the subcommittee has provided today, and I look forward to responding to your questions.

ENCLOSURE 1

A RENEWED SPIRIT OF DISCOVERY

THE PRESIDENT'S VISION FOR U.S. SPACE EXPLORATION—PRESIDENT GEORGE W. BUSH, JANUARY, 2004

Background

From the Apollo landings on the Moon, to robotic surveys of the Sun and the planets, to the compelling images captured by advanced space telescopes, U.S. achievements in space have revolutionized humanity's view of the universe and have inspired Americans and people around the world. These achievements also have led to the development of technologies that have widespread applications to address problems on Earth. As the world enters the second century of powered flight, it is time to articulate a new vision that will define and guide U.S. space exploration activities for the next several decades.

Today, humanity has the potential to seek answers to the most fundamental questions posed about the existence of life beyond Earth. Telescopes have found planets around other stars. Robotic probes have identified potential resources on the Moon, and evidence of water—a key ingredient for life—has been found on Mars and the moons of Jupiter.

Direct human experience in space has fundamentally altered our perspective of humanity and our place in the universe. Humans have the ability to respond to the unexpected developments inherent in space travel and possess unique skills that enhance discoveries. Just as Mercury, Gemini, and Apollo challenged a generation of Americans, a renewed U.S. space exploration program with a significant human component can inspire us—and our youth—to greater achievements on Earth and in space.

The loss of Space Shuttles *Challenger* and *Columbia* and their crews are a stark reminder of the inherent risks of space flight and the severity of the challenges posed by space exploration. In preparation for future human exploration, we must advance our ability to live and work safely in space and, at the same time, develop the technologies to extend humanity's reach to the Moon, Mars, and beyond. The new technologies required for further space exploration also will improve the Nation's other space activities and may provide applications that could be used to address problems on Earth.

Like the explorers of the past and the pioneers of flight in the last century, we cannot today identify all that we will gain from space exploration; we are confident, nonetheless, that the eventual return will be great. Like their efforts, the success of future U.S. space exploration will unfold over generations.

Goal and Objectives

The fundamental goal of this vision is to advance U.S. scientific, security, and economic interests through a robust space exploration program. In support of this goal, the United States will:

—Implement a sustained and affordable human and robotic program to explore the solar system and beyond;
—Extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations;
—Develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration; and
—Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.

Bringing the Vision to Reality

The Administrator of the National Aeronautics and Space Administration will be responsible for the plans, programs, and activities required to implement this vision, in coordination with other agencies, as deemed appropriate. The Administrator will plan and implement an integrated, long-term robotic and human exploration program structured with measurable milestones and executed on the basis of available resources, accumulated experience, and technology readiness.

To implement this vision, the Administrator will conduct the following activities and take other actions as required:

Exploration Activities in Low Earth Orbit

Space Shuttle

—Return the Space Shuttle to flight as soon as practical, based on the recommendations of the Columbia Accident Investigation Board;
—Focus use of the Space Shuttle to complete assembly of the International Space Station; and
—Retire the Space Shuttle as soon as assembly of the International Space Station is completed, planned for the end of this decade;

International Space Station

—Complete assembly of the International Space Station, including the U.S. components that support U.S. space exploration goals and those provided by foreign partners, planned for the end of this decade;
—Focus U.S. research and use of the International Space Station on supporting space exploration goals, with emphasis on understanding how the space environment affects astronaut health and capabilities and developing countermeasures; and
—Conduct International Space Station activities in a manner consistent with U.S. obligations contained in the agreements between the United States and other partners in the International Space Station.

Space Exploration Beyond Low Earth Orbit

The Moon

—Undertake lunar exploration activities to enable sustained human and robotic exploration of Mars and more distant destinations in the solar system;
—Starting no later than 2008, initiate a series of robotic missions to the Moon to prepare for and support future human exploration activities;
—Conduct the first extended human expedition to the lunar surface as early as 2015, but no later than the year 2020; and
—Use lunar exploration activities to further science, and to develop and test new approaches, technologies, and systems, including use of lunar and other space resources, to support sustained human space exploration to Mars and other destinations.

Mars and Other Destinations

—Conduct robotic exploration of Mars to search for evidence of life, to understand the history of the solar system, and to prepare for future human exploration;
—Conduct robotic exploration across the solar system for scientific purposes and to support human exploration. In particular, explore Jupiter's moons, asteroids and other bodies to search for evidence of life, to understand the history of the solar system, and to search for resources;
—Conduct advanced telescope searches for Earth-like planets and habitable environments around other stars;
—Develop and demonstrate power generation, propulsion, life support, and other key capabilities required to support more distant, more capable, and/or longer duration human and robotic exploration of Mars and other destinations; and
—Conduct human expeditions to Mars after acquiring adequate knowledge about the planet using robotic missions and after successfully demonstrating sustained human exploration missions to the Moon.

Space Transportation Capabilities Supporting Exploration

—Develop a new crew exploration vehicle to provide crew transportation for missions beyond low Earth orbit;
  —Conduct the initial test flight before the end of this decade in order to provide an operational capability to support human exploration missions no later than 2014;
—Separate to the maximum practical extent crew from cargo transportation to the International Space Station and for launching exploration missions beyond low Earth orbit;
  —Acquire cargo transportation as soon as practical and affordable to support missions to and from the International Space Station; and
  —Acquire crew transportation to and from the International Space Station, as required, after the Space Shuttle is retired from service.

International and Commercial Participation

—Pursue opportunities for international participation to support U.S. space exploration goals; and
—Pursue commercial opportunities for providing transportation and other services supporting the International Space Station and exploration missions beyond low Earth orbit.

ENCLOSURE 2

National Aeronautics and Space Administration
President's FY 2005 Budget Request

(Budget authority, $ in millions)	FULL COST						Chapter Number
By Appropriation Account	Est. Conf. Rept.						
By Enterprise	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	
By Theme							
Exploration, Science & Aeronautics	**7,830**	**7,760**	**7,869**	**8,320**	**8,900**	**9,091**	ESA-SUM 1
Space Science	**3,971**	**4,138**	**4,404**	**4,906**	**5,520**	**5,561**	ESA 1
Solar System Exploration	1,316	1,187	1,202	1,300	1,392	1,438	ESA 2
Mars Exploration	595	691	724	944	1,188	1,268	ESA 3
Lunar Exploration		70	135	280	375	420	ESA 4
Astronomical Search for Origins	899	1,067	1,196	1,212	1,182	927	ESA 5
Structure & Evolution of the Universe	406	378	365	382	425	457	ESA 6
Sun-Earth Connections	755	746	781	788	958	1,051	ESA 7
Earth Science	**1,613**	**1,485**	**1,390**	**1,368**	**1,343**	**1,474**	ESA 8
Earth System Science	1,522	1,409	1,313	1,290	1,266	1,397	ESA 9
Earth Science Applications	91	77	77	77	77	77	ESA 10
Biological & Physical Research	**985**	**1,049**	**950**	**938**	**941**	**944**	ESA 11
Biological Sciences Research	368	492	499	496	500	502	ESA 12
Physical Sciences Research	357	300	220	210	210	210	ESA 13
Research Partnerships & Flight Support	260	257	232	232	231	232	ESA 14
Aeronautics*	**1,034**	**919**	**957**	**938**	**926**	**942**	ESA 15
Aeronautics Technology	1,034	919	957	938	926	942	ESA 16
Education Programs	**226**	**169**	**169**	**171**	**170**	**170**	ESA 17
Education Programs	226	169	169	171	170	170	ESA 18
Exploration Capabilities	**7,521**	**8,456**	**9,104**	**9,465**	**9,070**	**8,911**	EC-SUM 1
Exploration Systems*	**1,646**	**1,782**	**2,579**	**2,941**	**2,809**	**3,313**	EC 1
Human & Robotic Technology	679	1,094	1,318	1,317	1,386	1,450	EC 2
Transportation Systems	967	689	1,261	1,624	1,423	1,863	EC 3
Space Flight	**5,875**	**6,674**	**6,525**	**6,524**	**6,261**	**5,598**	EC 4
International Space Station	1,498	1,863	1,764	1,780	1,779	2,115	EC 5
Space Shuttle	3,945	4,319	4,326	4,314	4,027	3,030	EC 6
Space Flight Support	432	492	435	430	456	453	EC 7
Inspector General	**27**	**28**	**29**	**30**	**31**	**32**	IG 1
TOTAL	**15,378**	**16,244**	**17,002**	**17,815**	**18,001**	**18,034**	
Year to year increase		5.6%	4.7%	4.8%	1.0%	0.2%	

*In FY 2004 Aeronautics and Exploration Systems will become separate Enterprises

NOTE: May not add due to rounding

[CLERK'S NOTE.—The additional information referred to has been retained in Committee files.]

Senator BOND. We've been joined by the chairman of the full committee. Mr. Chairman, would you have any comments?

STATEMENT OF SENATOR TED STEVENS

Senator STEVENS. I welcome the Administrator, and I congratulate him on the success of his mission so far, and look forward to working with him in the years to come.

Mr. O'KEEFE. Thank you, sir.

Senator STEVENS. I think we ought to each put in a little reservation for some space on that trip in 2015.

Mr. O'KEEFE. Thank you, Mr. Chairman, it's a pleasure to see you.

Senator BOND. Mr. Chairman, I would be happy to defer to you. You can have my slot.

Senator STEVENS. Well they sent something up. I think it was 80 years of age, and I think I will put in for my reservation when I'm 90 years of age.

SHUTTLE RETIREMENT

Senator BOND. If you want to go, we will work it out.

Mr. Administrator, at this time, the shuttle is the only U.S. vehicle capable of taking astronauts to and from space. Under the new vision for NASA, the shuttle would be retired and the space station constructed and completed in 2010. That's optimistic.

A new Crew Exploration Vehicle (CEV) would be developed and fully operational for orbital missions by 2014. What will be the consequences of a 4-year and possibly longer hiatus, in U.S. flown human space flights. And how many staff will we lose and how will we restart the manned-space flight program after a 4-year hiatus?

Mr. O'KEEFE. That's a fair point and one that really devoted an awful lot of attention during this inter-agency process towards that kind of gap period. Because as you recall, in our efforts to develop the Orbital Space Plane (OSP), last year, of which the Crew Exploration Vehicle, Project Constellation, is a natural evolution and derivative of that. And builds on everything we did on the Orbital Space Plane program.

The earliest we could attain a full-up, human-rated system based on all the trade studies in the industry assessment, was by the 2010 time frame. So the approach that we've taken here with the Crew Exploration Vehicle and Project Constellation, as articulated in the Vision for Space Exploration, is to use the spiral development approach to demonstrate the capability as early as 2008, on the first spiral that needs to be done.

So you would build each of the respective components and parts and launch as necessary, and as ready, to demonstrate that capability. That will give us time to assess this question of what kind of a gap might actually exist. It could occur, if it were successful, that we could move this much earlier. The catch is we're not building this on a success-driven strategy that inserts schedule pressure in that process and makes it a demand, so that you can't retire before the time.

CREW TRANSFER REQUIREMENTS

Senator BOND. What are we going to have to pay Russia for taking U.S. astronauts to and from the ISS? And how is NASA going to pay for such services given the Iran Non-Proliferation Act prohibiting NASA from paying Russia for ISS related activities.

Mr. O'KEEFE. Well, sir——

Senator BOND. What are they getting for it?

Mr. O'KEEFE. Sir, so far it's part of their agreement and so we have paid not a dime more for their efforts in the last year to fully complement the crew transfer requirements to the International Space Station, to and from, given the grounding of the shuttle since February 1, 2003, in the wake of the Columbia tragedy.

They have fulfilled the commitment. That is due to expire in 2006. We're in the works of negotiating with them what additional

challenges, among all of us as partners, of what those additional costs will be in expanding the number of crew expedition missions. Because now, at this point, we can expand the crew size beyond three once we reach U.S. core complete configuration in a year, or so, after we return to flight.

From there, debating exactly what number of flights would be necessary from Soyuz vehicles, or after return to flight how many crew transfer requirements would be taken on the shuttle as part of our ongoing negotiations. So, in the course of that, I wouldn't want to predict right now what that may import. But so far it has cost nothing extra and nothing different. I associate myself entirely with your remarks, sir, that the partners have stepped up in this past year and demonstrated the real depth of this partnership by following through on their commitments and it hasn't taken any additional costs on the part of the United States in order to sustain the International Space Station capabilities thus far.

SOYUZ CAPABILITIES

Senator BOND. Would the Soyuz meet the test that the Gehman Committee applied to the shuttle?

Mr. O'KEEFE. Yes, sir.

Senator BOND. Has there been a similar examination of the safety of the Soyuz?

Mr. O'KEEFE. Yes, sir.

Senator BOND. To make sure that we're sending them up on a safe vehicle?

Mr. O'KEEFE. The approach that we have used now consistently, and have really intensified, certainly in this period, that is the only means of transfer to and from the station, and return capability in the event of an emergency is by Soyuz, is to commission at every single flight a joint Russian-U.S. team of folks that were used.

As a matter of fact, during the shuttle/Mir days, which was represented by Professor Amfimov, from the Russian Rosaviakosmos and Tom Stafford, an Apollo astronaut, with a team of folks who certify each and every flight as a prior flight readiness review effort, roughly a month before each of the expedition's crews depart.

They come up with a comprehensive assessment of the safety standards that comport with that. We have insisted and the Russians have been extremely cooperative on this, of understanding the same parameters of medical, as well as technology standards that we adhere to, and they have been extremely helpful in working through that. So we have adjusted crews, we have made changes, and we have done all kinds of things as a consequence of the Stafford-Amfimov certification that occurs each and every flight. They will be meeting again here in about 3 weeks' time in preparation of the Expedition 9 crew which is due to launch in the middle of April.

Senator BOND. Senator Mikulski.

HUBBLE SERVICING MISSION

Senator MIKULSKI. Thank you very much, Mr. Chairman.

And I know my colleagues are here and so I will get right to my Hubble questions.

Mr. O'Keefe, you have now received the Gehman letter containing his analysis of the Hubble servicing mission. Could you tell me your reaction to the Gehman letter, particularly the aspect where he recommends that we get additional advice. And our request to you that we go to the National Academy of Sciences for a more amplified analysis.

Mr. O'KEEFE. Thank you, Senator. Indeed, I associate myself entirely with your comments that Admiral Gehman issued a typical characteristically thoughtful commentary and review, and did in fact follow through on what I had suggested to you in our previous conversations, was for him to offer his unique view and perspective on this particular question. I think he offered that in addition to your comments, in a way, in which he said, by the changes in the non-station missions. We knew we're essentially reducing the requirements. Reducing the rigor of our requirements increases the risk and can't be seen any other way.

That's in large measure looking at the Return to Flight challenges that we have been examining to comply with every one of those recommendations. Again, I am delighted to hear that your view, and I believe that of Congress, has been to say, yes, we are embracing the actions of the Columbia Accident Investigation Board's recommendations. It is our intent to implement them for each and every flight to assure that we do this to mitigate the risk to as low as we possibly can.

Any further examination beyond that I think is welcomed. And to be sure, to the extent that on the Hubble servicing mission, and all of the alternatives that we have now, I think are excited by a Request for Information we issued in the early part of February, to ask what other approaches would we use to extend the battery life? What would we do to de-orbit in the early part of the next decade? What would we do to boost the capability, if need be?

All of those factors, if we could include that in the equation—to look at what is, I believe, the broader objectives of what we all agree to, which is to get the maximum service life out of Hubble that we can—would be an acceptable approach to it.

So asking the National Research Council through the National Academy of Sciences to examine that broader question of the range of alternatives and approaches that we use in order to maximize the service life of Hubble is something I have already engaged in discussions with Len Fisk, who runs the National Research Council, to determine their interest. They're very interested in pursuing that. As I understand you've done the same.

We would welcome any ideas in terms of the broader scope of it in order to extend beyond the service life that we had anticipated of 2005. We're already going to exceed that. Let's figure out how we can do even better than that, short of encountering the risks that would be involved in a servicing mission.

That ought to be included as well, and that's why the determination and judgment that I reached is that this is a higher risk. But if they look at the full plan and range of options, that's an approach that I think could be extremely beneficial for us all.

SERVICE MISSION RISK

Senator MIKULSKI. First of all, that's a very constructive response, and I am going to thank you.

Let's be sure that we understand the response. Number one, what Gehman recommended was a look at risk versus value. In other words, look at the value. Now what we asked for in the Mikulski-Bond, or Bond-Mikulski letter is for the National Academy of Sciences to look at the risk involved in a service mission, and what could make it as safe as possible, et cetera.

What we want is, No. 1, implement what Gehman said he wanted studied. What you're saying, in addition to what Gehman wanted studied, and what I want studied on should we have a servicing mission, you're also wanting the National Academy to look at what else would be needed to extend the life of the Hubble. Is that correct?

Mr. O'KEEFE. Absolutely, Senator. I think that—oh, I'm sorry, please go ahead.

Senator MIKULSKI. And then the third could be alternative methods for servicing. You know, there's a save the Hubble website. There's ideas coming in from all over the world. I am not asking the National Academy of Sciences to look at all of them. These ideas are what space scientists are all about, it is wild and creative. I wonder if you would also want them to look at alternative servicing methods, or——

Mr. O'KEEFE. Exactly. I think that's the approach. Let's go, and again, in the spirit of your comment, let's be sure that we're in full agreement on what the objectives would be here. The first one is, if we could fully agree that the objective is to comply with every recommendation of the CAIB for every shuttle flight, that's what NASA has embraced and that's what we intend to do.

Senator MIKULSKI. And we're on the same broadband on that.

Mr. O'KEEFE. Yes, and I am very grateful to you, Senator, because that's the part that really worries me most.

Senator MIKULSKI. So no matter what, because in the Gehman letter, he says this, the bottom line, says Admiral Gehman, shuttle risks are dangerous, and we should fly the minimum number necessary to complete mission. Almost all of the risk is concentrated in the front and the back of the mission. Where one goes into orbit makes little difference. That's one item.

But in his final paragraph, he says, I suggest only a deep and rich study of the entire gain-risk equation can answer the questions of whether an extension of the life of the wonderful Hubble telescope is worth the risk. That's what I would like the National Academy of Sciences to look at.

Your proposal, in addition to that, not in lieu of, would be to look also at should we not have a servicing mission, then how could we extend the life of the Hubble in its continued ability to discover while we're waiting. And I am now also wondering about your reaction to assessing alternative servicing methods as well.

Mr. O'KEEFE. No, as you suggested——

Senator MIKULSKI. Is that——

Mr. O'KEEFE. Yes, ma'am. As you suggested, the approach we used in our Request for Information because of this flood of interest

in various ways of looking at the challenge of moving the Hubble closer to the station, there are a number of different ideas that are potentially very interesting, and could be workable. And then there are others that are really kind of interesting.

As a consequence, the approach that we took to separate the wheat from the chaff, I think is really critical. The two things that I think would really guide this approach is first and foremost, and inviolate, proposition that we have to comply with every recommendation of the CAIB report.

So, independent of the return question, what I cannot abide the notion of, and what my judgment has been driven on, is the idea of commissioning a servicing mission that isn't in comport with every one of those requirements. That's the part that I want to be sure of that they're extremely focused on. Therefore, they'll have to delve into the full range of Return to Flight challenges, everything that we're doing in order to comply with every single recommendation. Because anything that says, it close but it's not close enough, is in my judgment not acceptable as a means to do this.

The second matter would be, I think that we're all in agreement on, what can we do to extend the service life. And the ways that we can do that, beyond servicing, is to draw battery power at a much different rate, which therefore changes the operational protocols of how we utilize Hubble.

FINAL SERVICING MISSION STUDY

Senator MIKULSKI. Mr. Administrator, the red light is blinking. We're going to wait for your opinions and also the Academy on this.

While I would suggest that our staffs meet and make sure that we're all clear in the direction we're going in. And I believe we are.

The last paragraph, though, to this which says, we request that you take no action to stop, suspend, or terminate any contracts or employment in connection with the final servicing mission until this study is completed.

Mr. O'KEEFE. Let me offer to you this proposition which is—I don't know what the answer to that one is. Having just received your letter this morning, I don't know what the result would be of each of those contracts.

It falls into at least three categories that I was able to eyeball quickly. First, is those efforts that have already been completed, and therefore would naturally wind down, whether we had pursued a servicing mission or not. Second, category would be the instruments and how those would be employed for other purposes as well. How we could use them in the future, and we're committed to doing that. The third, would be to focus on the range of other options to extend battery power, to change operational protocols. To do all of those things to get the maximum service life we can beyond fiscal year 2005, which was the design date for the Hubble to begin with. Those are the three things that I would look to, and if you would give me an opportunity to go examine these——

Senator MIKULSKI. Well, I think that is a fair request on your part.

First of all, I want to thank you for responding to my initial request for a second opinion, to our request for additional study from

the National Academy of Sciences, knowing that you just got our response, just as we just got the Gehman response.

And we look forward to making sure that we do not lose time, or talent with what we have by premature cancelling of anybody's job or anybody's contract.

Mr. O'KEEFE. I understand.

Senator BOND. Thank you very much.

Mr. O'KEEFE. If I could give one final comment or observation on this. Again, the judgment call that this turns on is whether or not we believe we can mitigate the risks and comport with all of the recommendations of the Board. And do it at a time that is timely enough in order to actually complete the servicing mission. And that's the part that's in doubt. Because once the batteries go, the Hubble survives for about 6 to 10 hours and then that's it. It goes cold.

So, as a consequence, putting all of our eggs in that one basket doesn't work. It is not something that I think is an acceptable risk. As a consequence looking at the full range of what we do to get the service life is what our commitment is, and that's what we've been pursuing. We would be delighted to get the Academy's view of what else they think we could be looking at in order to pursue that common objective in comport with the CAIB recommendations.

And it's got to be done expeditiously in order to get through this.

Senator BOND. Okay.

Mr. O'KEEFE. So, I am in agreement with you, and we will work through what the immediate challenges would be from the contractual standpoint in the immediate period—and that's something we'll get back to you very, very expeditiously in terms of what the combination will be.

You know that some of it is going to wind down, because the work is finished. Some of its going to be towards instruments that we could employ for other activities. And some of it may well be towards other alternatives we can look to extend the service life.

Senator BOND. Thank you.

Mr. O'KEEFE. All three of those would be acceptable with NASA.

Senator BOND. Thank you, Mr. Administrator.

Senator MIKULSKI. Thank you.

Senator BOND. Let me turn now to——

Mr. O'KEEFE. Thank you.

Senator MIKULSKI. I think our battery just ran out.

Mr. O'KEEFE. Thank you, Senator. I appreciate your willingness to do that.

Senator BOND. Senator Stevens.

NON-SPACE NEEDS OF THE PROGRAM

Senator STEVENS. Well, Administrator O'Keefe, you make us all proud of the job that you're doing with NASA and I want you to know that I personally have great confidence in what you're doing. I hope you don't misunderstand my question.

My question is, with this vision, and I appreciate that you brought the President's comments to us this morning. With this vision, what is going to happen with the other non-space needs of the programs that NASA is involved in during this period of growth?

Mr. O'KEEFE. Sir.

Senator STEVENS. Are we going to see a change in the other missions?

Mr. O'KEEFE. Well, if anything, one of the things that I have found absolutely amazing is the organizational response to this. This now forces us to integrate, to think about applications on a much broader basis than we ever did before.

One of the absolute indictments that the Columbia Accident Investigation Board offered, that others have offered, and lots of commentators and critics have suggested, is that the Agency has been stove-piped. It has been looking at different categories and never inter-relates activities.

So if anything, what we're seeing is a consequence of this. And we've been motivated to move in the direction of how do we apply all of those capabilities towards this central set of objectives and direction that the President has granted, and sent to us and said, that's what I expect you to do.

Therefore, applying all of those capabilities for earth sciences, aeronautics, biological and physical research, space flight and space science, in addition to the education and inspiration of the next generation of explorers, this is something that now I think is a much more integrated collaborative effort in that direction.

I don't see a big diminution. In those central mission objectives in what the Agency has been chartered to go do. There will be differences of view over whether or not we should do a little more or a little less in one area or another. That's something, I think, that's well within the range of manageable as a discussion.

But for the purposes of this objective it is a central focus. It's a much greater level of clarity than the Agency has had in decades. As a consequence, that's what I think the enthusiasm will be rallied around. There are modifications that can be made as we move along, because nothing is so intractable as to preclude any one of those options.

Senator STEVENS. Well, I would be precluded from discussing some of the missions, but are there classified missions of NASA going to be diminished because if the activities that you have described?

Mr. O'KEEFE. No, sir.

Senator STEVENS. Thank you.

Thank you, Mr. Chairman.

Senator BOND. Thank you, Senator Stevens.

Senator Shelby.

Senator SHELBY. Thank you, Mr. Chairman.

Mr. Administrator, during the months of the extensive and careful deliberations which led to the President' new space vision, would you tell us what input, if any, was sought from industry during this process. We've been told that there was none sought.

Mr. O'KEEFE. Well, the process that we employ, that the President sent us off on, is an inter-agency process. In other words, public servants engaged in the activity. What we were all charged to do, from the Defense Department, the State Department, the Commerce Department, the Office of Science and Technology Policy, and certainly NASA, and through the process that was put together of the National Security Council and the Domestic Policy Council, was to bring in all of those external views that were being

debated in these broader fora. Both within the oversight committees of Congress as well as the broader conferences and symposia that were conducted after the CAIB released its position.

So, therefore the industry views, positions and thoughts were brought into that equation in order to reach the range of options. And at one point, we looked at so many options, we could hardly keep tabs on them all, in terms of which approach we should take. The President's engagement on this point was to consistently solicit that broader range of views, and that's where we ended out, is in concert with all of those perspectives as well.

Senator SHELBY. We have to use foreign launch systems now. The budget it seems chooses to use them in the future, which is troubling to some of us.

Mr. O'KEEFE. I couldn't comment one way or the other, sir. I understand your point, but I am not—I don't think we have any greater or lesser international involvement or engagement in the activities that the President has directed us to proceed with than what we have been encountering now for several years. So I don't anticipate or see any intensification of that effort.

EXPLORATION SYSTEMS

Senator SHELBY. Could you briefly explain the process on going within code "T" to engage industry as you formulate requirements, definitions and program planning decisions in the new space exploration program. And particularly Project Constellation.

Mr. O'KEEFE. Yes, sir. No, thank you for the question. The approach that we were taking, and the organizational code that you've referred to is the Office of Exploration Systems.

Senator SHELBY. Okay.

Mr. O'KEEFE. It was announced the day after the President's speech. The objective was, and we had been working for the previous few months in pulling together all of the components of what we do around NASA, to look at large scale systems integration challenges. The engineering challenges of delivering on a set of programs that require lots of integration.

So again, in my response to Senator Stevens, this is one of the consequences, one of the amazing developments as the result of the President's charge, is to start looking at the full range of activities that we have in the Agency and applying them towards common solution.

So what the Office of Exploration Systems is now looking to under Project Constellation, under Project Prometheus, and a number of others, is to kind of pull together all of those efforts to integrate independently of the mission objectives so that we get a common solution.

We are out engaging the industry very actively, to look at a number of different approaches that would call for acquisition strategies like spiral development that I referred to earlier for the Crew Exploration Vehicle. As well as engagement with the broader industry community on Project Prometheus on how to generate power and propulsion, something we've never had in a spacecraft that now could be used as a means to inform those broader acquisition strategies.

So, we are out there soliciting in a much broader case, as is Craig Steidle, our new Associate Administrator for Exploration Systems, to include all of those industry interests that were basically pulled together as the result of the exceptional efforts during the Orbital Space Plane effort was engaged in last year.

CREW EXPLORATION VEHICLE

Senator BOND. Mr. Administrator, how much will the Crew Exploration Vehicle build on the work already done for the orbital space plane? And would you discuss the benefits?

In other words, I hope that you're not going to try and reinvent the wheel.

Mr. O'KEEFE. No, sir. No, I think that you're right on. In many ways, a lot of what we engaged in a year ago for the Orbital Space Plane, we would have to do now, had we not engaged in it over the previous year. Because it really defined some of the fundamental requirements of what is necessary for developing a capability using existing launch capacity for what would be beyond low-Earth orbit. Because, as you know, shuttle is restricted to low-Earth orbit by virtue of its characteristics.

Much of what we derived from that experience evolved over that time towards an adaptability towards capabilities that could go beyond low-Earth orbit. So much of what we did in the Orbital Space Plane, I would say, is at least two-thirds common with the kinds of challenges we would meet. Because much of what is challenging about these efforts is getting off this planet and going anywhere.

The thermal protection system requirements, all of those things, then become gradients of that as well as the capacity you want to bring with you for wherever it is you want to go, for whatever duration or length of time.

So, in many ways, a lot of these hard questions were very, very professionally run to ground during the course of that OSP effort a year ago. As a result, we're able to launch right from that to this next level. We have got a running start as a result of that engagement.

Senator SHELBY. I know that my time is almost up, but I want to ask one more question, if I could.

FUNDING REDUCTIONS IN PHYSICAL SCIENCE RESEARCH

Senator BOND. Without objection.

Senator SHELBY. Thank you.

Mr. Administrator, I am concerned as a lot of other people are about this significant reduction in funding for physical science research. This is a big departure.

Three distinguished professors in research science recently wrote to me to share the following sentiment regarding this dramatic cut to physical research.

And I just want to share with you excerpts.

While NASA has the mission of planetary exploration it also has the goal of improving life on Earth. Towards that goal it is the only American agency with the unique capability to conduct physical science research in the virtual absence of gravity, which we all know. Now, I'll skip on down a little bit.

As you're aware, NASA since you're the Administrator, is planning to further reduce all physical science research on the ISS and the shuttle, in particular research on material science. It is our understanding that the already reduced number of materials, science flight investigations from 24 to 12, will be further reduced to only a couple of principal investigators.

And then, I'm going to turn to crew health. This is another excerpt of the letter. Crew health is not just biological-astronautics. Both Challenger and Columbia crashed due to materials failure, not motion sickness, bone loss or radiation exposure. Improvements in materials have powered all industrial revolutions. A balanced research portfolio will be critical to success in NASA's exploration thrust.

I hope you will look at this letter. And we've talked about this already.

Mr. O'KEEFE. Yes, sir.

Senator SHELBY. Privately, but these are some of my concerns and I believe they are the concerns of a lot of people on the committee.

Mr. O'KEEFE. I would be delighted to take a look at it, Senator. And I thank you for raising the issues. It is about priorities. There is no question.

Senator SHELBY. Priorities.

Mr. O'KEEFE. They're very difficult to do, but in that respect, the President's clear direction to us is that we look at utilizing the capacity of the station and focus our research endeavor towards understanding expedition missions. That's largely life sciences, physiology.

Senator SHELBY. Sure.

Mr. O'KEEFE. But it also includes material sciences kinds of activities too, to sustain activities for long periods of time.

Senator SHELBY. We've got so much to learn there to benefit us.

Mr. O'KEEFE. Yes, sir. Without question.

Senator SHELBY. I know that Senator Mikulski and Senator Bond have been in the forefront of all of this. That we have benefitted so much from NASA back here as well as out in space.

Mr. O'KEEFE. Yes, sir.

Senator SHELBY. Mr. Chairman, I have a number of other questions that I want to submit for the record for the Administrator. And I appreciate your indulgence.

Senator BOND. Thank you very much, Senator Shelby.

We're going to have a number of questions for the record, otherwise we would be here all day.

Mr. O'KEEFE. Thank you, sir.

AERONAUTICS FUNDING

Senator BOND. Mr. Administrator, following on Senator Stevens' question, and sort of related to what Senator Shelby asked, what role do you see for NASA in the vitally important national industry in aeronautics? Did aeronautics take a hit in this budget? Is aeronautics going to become a poor stepchild?

Mr. O'KEEFE. Not at all, sir. No, I think that there are two major areas that we need to continue to concentrate on, and part of what I think you're seeing in the budget projections is the need for great-

er definition as we move along and work through each of these successes in terms of applications.

But the two areas that I think are most profound are, No. 1, there are a lot of capabilities that we have seen in the aeronautical system side that are so important for the purpose of continuing our activities on shuttle, and a number of other space science-related activities through the NASA Engineering and Safety Center (NESC), which has been set up as part of the aeronautics enterprise, part of that function, in order to pull together all of those capabilities.

This is one of the organizational legacies of the Columbia Accident Investigation Board report to pulling together those inter-disciplinary skills necessary to look and inform the kinds of challenges we have on trend analysis and a number of those kinds of things that were called out in that report. So there is a very dominant role in those skill areas that will now have applications.

For example, it is not by accident, that now the Deputy Director of the Kennedy Space Center is a guy who came from an aeronautics background. So here he is looking at launch operations activities, and he has also got a tremendous amount of skill and background in aeronautics functions.

Second area is to look at those kinds of things that look at air space management and a range of aviation security and safety-related activities. That is a dominant focus and priority of what we have now concentrated on in the aeronautics area.

To your broader point, I think, in raising your opening statement, how we look at inter-relationships, for example, with the Defense Department, through hypersonics, and a number of other approaches of developing next generation kinds of propulsion power, and design requirements is what we intend to do very closely in comport with the Defense Department.

So all of those factors together, I think, are guiding us, adjustments that may need to be made will be informed by our successes in all three of those areas.

Senator BOND. I appreciate your answer. I have the feeling that it may be incidental for the benefit for aeronautics and I think we need to explore further whether there is going to be the kind of directed investigations that would be needed for us to maintain a healthy aeronautics industry, domestic and international civilian industry in the United States.

What upgrades to the shuttle should NASA continue to pursue? And what new launch vehicle or vehicles may need to be developed to carry cargo up? If we're going to have the International Space Station, they're going to need cargo.

And if we're going to go to the Moon and set up a launch facility, we've got to haul a lot of stuff. We're going to need some big trucks. What are your plans for those?

Senator MIKULSKI. Good point.

Mr. O'KEEFE. Well, the first part of your question, I think relates very clearly, Mr. Chairman, and I agree with, is what upgrades and capabilities or modifications to the shuttle do we need to continue with. The focus that we're now vectoring from, that was a Service Life Extension Program focus prior to last year, is now towards how do we maintain this capability, upgrade it and use it

with all the safety modifications necessary in order to mitigate risk through the end of this decade.

That's how long we intend to operate shuttle. We're going to continue on those upgrades, and we've got two out of the three orbiters that are in major modification right now. So during this period of time while the shuttle is grounded, while we're implementing all of these recommendations, we want to include those upgrades in order to improve this dramatically.

The second area is, I think, the requirements to Return to Flight—an immediate task right now. We're including those upgrades and, I think in your opening comments, you asked what are the costs and challenges of doing that. That's what is included in the Operating Plan that was just submitted to you, that can continue the activity, to incorporate those upgrades necessary.

CARGO CAPACITY REQUIREMENTS

The third dimension is, in the latter half of your question, focused on what kind of cargo capacity requirements we're looking to. Well, there are two basic areas that we're looking at there.

The first one is to develop and continue to build on the capabilities of our international partners, who have had the requirement to follow through for the International Space Station. It's a lot of lift, a lot of logistics requirements for the station, that will now be off of the space shuttle in the future, so that we can get the components up there and finish the construction of the station.

Second area would be to look at cargo lift capacities; frankly, some of them will be explored as a consequence of this earlier understanding we've reached and discussed on Hubble servicing, for example, robotically, autonomously, that could also inform that. So I think that may be an acceleration of what kind of launch requirements we would need to have, for what kind of lift requirements, in order to install what autonomously, robotically, over that span of time, that will give us a much deeper understanding of it.

So we will be building on existing capabilities and exploring other opportunities for lift capabilities for cargo in order to comply with the CAIB report to separate the crew from the cargo is our objective.

Senator BOND. Maybe I'm not quite clear, but all of these things that we're exploring are assuming, No. 1, either we have the shuttle, and if you're going to save money by not doing the shuttle recertification in 2010, I am gathering that there won't be a shuttle after 2010 to do the heavy lift. That leaves us dependent upon international partners or somebody else to do the heavy lift after 2010?

Mr. O'KEEFE. Oh, no, sir. Not at all.

That certainly is, there are competing options and alternatives there as well, within the United States, for our capability.

The capabilities we have for heavy lift vehicles are through the EELV with the Defense Department, the Atlas and Titan Programs that they maintain. Plus we are looking at how we might employ, for example, the shuttle shack—the solid rocket boosters, the external tanks, all of those things give us some lift capacity. We may need to reassemble, short of including the orbiter on that. There

are all kinds of capabilities we have and we have got to look to for launch capacity.

What is important about the way and the direction the President has given is that it lets us look at existing capabilities which are right now underutilized through the Defense Department.

So in working with them for launch services requirements, for the heavy lift, for expendable launch vehicle capability they have, plus what we are already using right now to lift shuttle are derivatives thereof, we have the kinds of existing capabilities that are right here in the United States, that certainly will have traction and capability in terms of whatever lift requirements we have for Project Constellation, as well as any cargo capacity that may be required in the future.

Senator BOND. I think that we will need to be hearing more specifics on which options you're pursuing.

Mr. O'KEEFE. Sure.

Senator BOND. Because I know there are a lot of possibilities out there.

Mr. O'KEEFE. Yes.

Senator BOND. But facing the end of the shuttle in 2010 we ought to be thinking now.

Mr. O'KEEFE. Absolutely.

Senator BOND. About how we're going to get all of this equipment up there.

Mr. O'KEEFE. Thank you very much, Mr. Chairman.

RETURN TO FLIGHT—CAIB RECOMMENDATIONS

Senator MIKULSKI. Thank you very much, Mr. Chairman.

Mr. Administrator, could you tell us, and I want to talk now about fully implementing the CAIB's recommendation on how to return to flight.

How much do you anticipate fully implementing the CAIB's recommendations. And what is your timetable on doing that? Do you hope to be able to do this all in one year?

Mr. O'KEEFE. Okay. Thank you, Senator. That's a very—it's an issue——

Senator MIKULSKI. Is it one orbiter a year? Or——

Mr. O'KEEFE. Yes, it is an issue that is consuming a lot of our focus and attention now, because again there is no day light on the commitment that we're going to implement those recommendations. Absolutely. There is not a day that goes by that I am not reminded of exactly what the consequences are of not doing that and why Columbia was lost.

Senator MIKULSKI. We all feel the same way.

Mr. O'KEEFE. So we're pursuing that. There are 29 recommendations, as you're aware, and 15 of which must be done before the Return to Flight.

We have a group we assembled last summer of roughly 25 or 30 experts in all kinds of disciplines and fields who are overseeing our activities in this. There is a regular update that we've been issuing since September, on a monthly basis, on every single step to comply with those 15 and that broader 29 recommendations overall.

That's publicly released. It's on the website, it's been released to all the committees of Congress, and we will continue to do that, not

only up to Return to Flight, but thereafter. We're going to continue this open effort all the way through.

RETURN TO FLIGHT COST

Senator MIKULSKI. Cost?

Mr. O'KEEFE. Sorry.

Senator MIKULSKI. Cost?

Mr. O'KEEFE. Cost right now in 2004 is established at $265 million, of which that has become a real serious challenge for us to implement this year, in light of the Congress's direction to reduce the International Space Station by $200 million. We've had to cover that reserve as a result, and we have to find $265 million within funds available in order to pursue this, because no additional funds were appropriated this past year. So we're scrambling to do that, in the operating plan. You have that. It was submitted here, identifies the kinds of resources to do that. A year ago, in 2003, we absorbed about $93 million in order to proceed with that.

Senator MIKULSKI. But Mr. Administrator——

Mr. O'KEEFE. I'm sorry.

Senator MIKULSKI. We're looking at how to be your partner to do this. So what do you need in fiscal year 2005 to do this?

Mr. O'KEEFE. Well——

Senator MIKULSKI. And what we also, in addition to that, have to look at reprogramming in fiscal year 2004 for you to stay the course in fiscal year 2004.

Mr. O'KEEFE. Yes, Senator.

Senator MIKULSKI. So you need more in fiscal year 2004 in some variation of coming up with a supplemental to implement this. This is the anchor from which all floats.

Mr. O'KEEFE. Okay.

Senator MIKULSKI. So that's one.

So what do we need to make sure? Do you have enough money in fiscal year 2004, or do we need to be ready to do something in partnership with you.

And No. 2, how much will you need for fiscal year 2005 to continue to make, to implement the $15 million we need to Return to Flight, but then the other $14 million——

Mr. O'KEEFE. Yes.

Senator MIKULSKI [continuing]. To make the $15 million workable.

Mr. O'KEEFE. Absolutely.

Senator MIKULSKI. And sustainable.

Mr. O'KEEFE. Absolutely. Now, in fiscal year 2004, as I mentioned, $265 million is how much we're absorbing now. Your assistance and support of that activity through our operating plan would be most appreciated now while we work through that.

In fiscal year 2005, the projections that we put in the budget involved here and covers about a $374 million increase in the fiscal year 2005 request that will implement all of these recommendations and continue along in that direction. It covers the broader area, not just the 15 recommendations, it's all 29 recommendations.

For example, the costs to operate, run NASA Engineering and Safety Centers. It's part of the expense involved in this, and other organizational changes that we have advanced. So let me give you

a complete list for the record of all of the things that's included in that, that's part of——

Senator MIKULSKI. But, roughly, it's about $375 million to $400 million.

Mr. O'KEEFE. In 2004.

Senator MIKULSKI. And you know how these things tend to go up.

Mr. O'KEEFE. In fiscal year 2005, as an increase. Yes, ma'am.

Senator MIKULSKI. Yes.

And do you need additional funds in fiscal year 2004?

Mr. O'KEEFE. Two hundred sixty-five million dollars is the amount we've proposed to reallocate and shift, and that's the operating plan that you have before the committee for your consideration.

Senator MIKULSKI. I see.

And when do you anticipate those 15 recommendations for Return to Flight to be done? Do you anticipate that they will be done in calendar 2004, or will this take us also into calendar 2005?

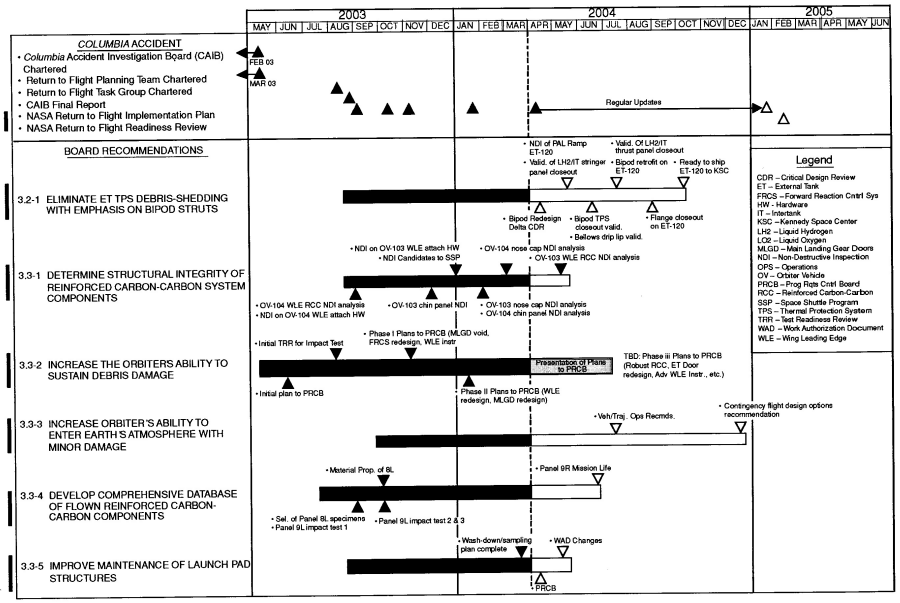
Mr. O'KEEFE. I anticipate, based on our current assessment of Return to Flight challenges that we should see implementation of all of those recommendations, 15, prior to Return to Flight, in this calendar year. That will be necessary in order to facilitate that prospect of any Return to Flight in the early part of next, if we're going to go the way——

Senator MIKULSKI. If you could furnish to the committee essentially a sequencing of the calendar if you will, so that we can get a sense of time frame.

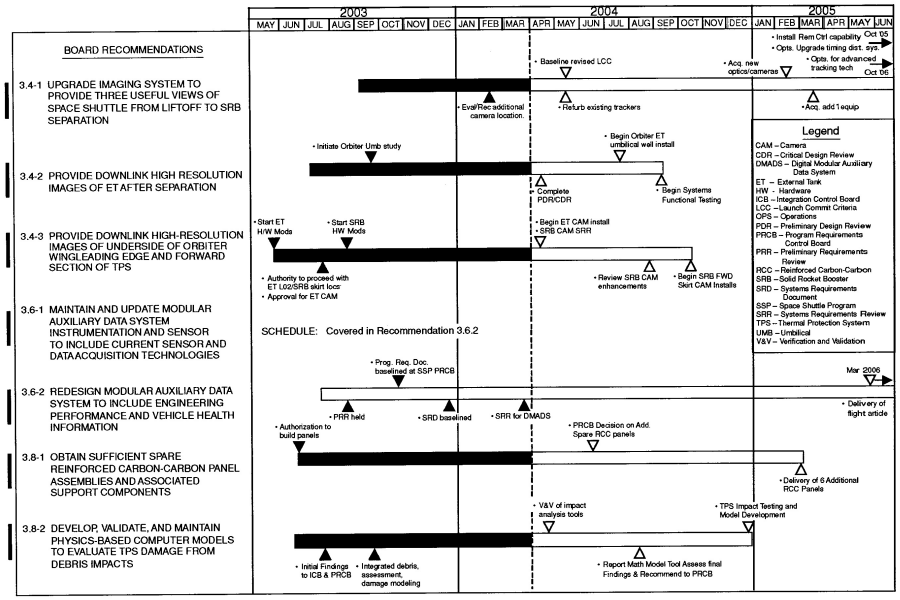
Mr. O'KEEFE. If I could, Senator, that's part of a last update that we last submitted. And we're going to update it again here in about 2 weeks' time. So we will positively provide that for you.

[The information follows:]

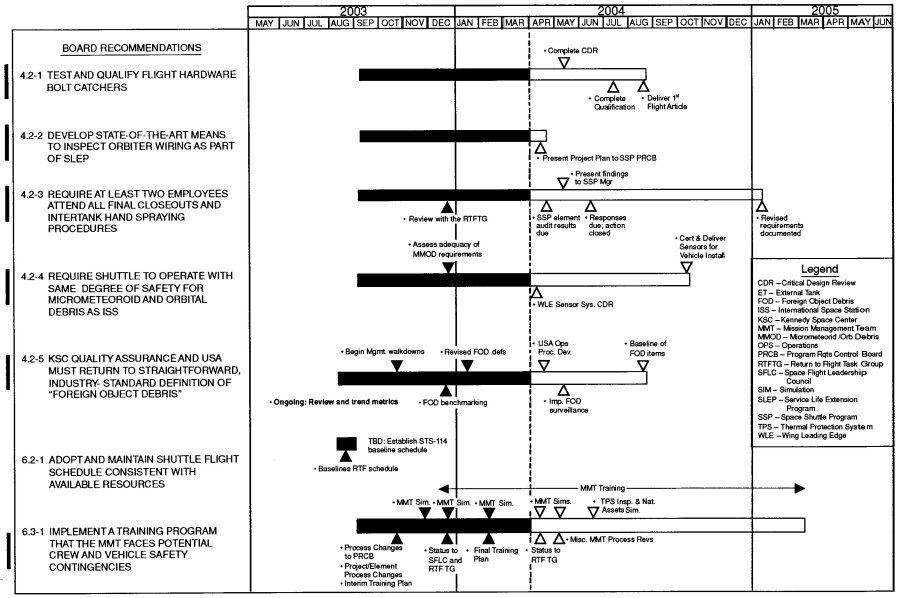
CAIB Recommendations Implementation Schedule



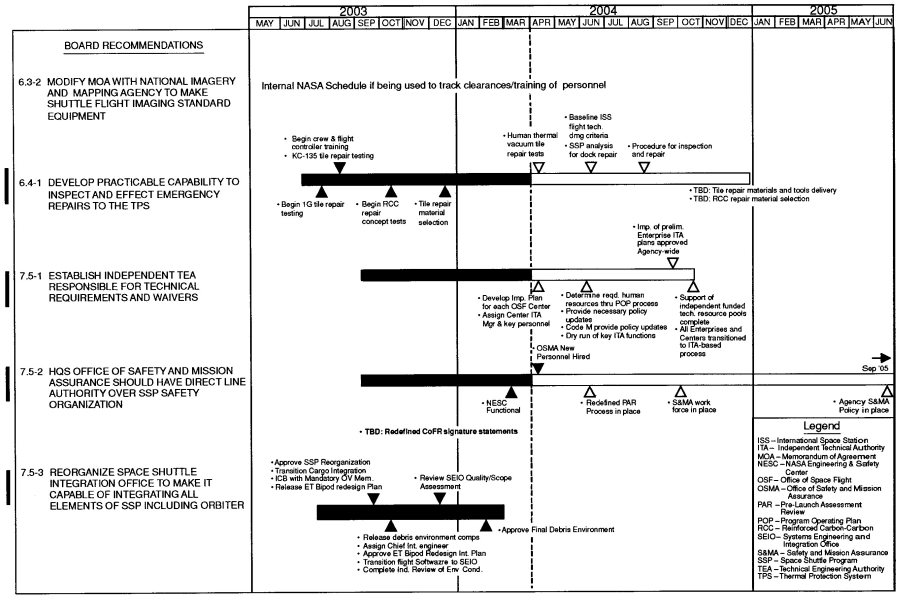
CAIB Recommendations Implementation Schedule



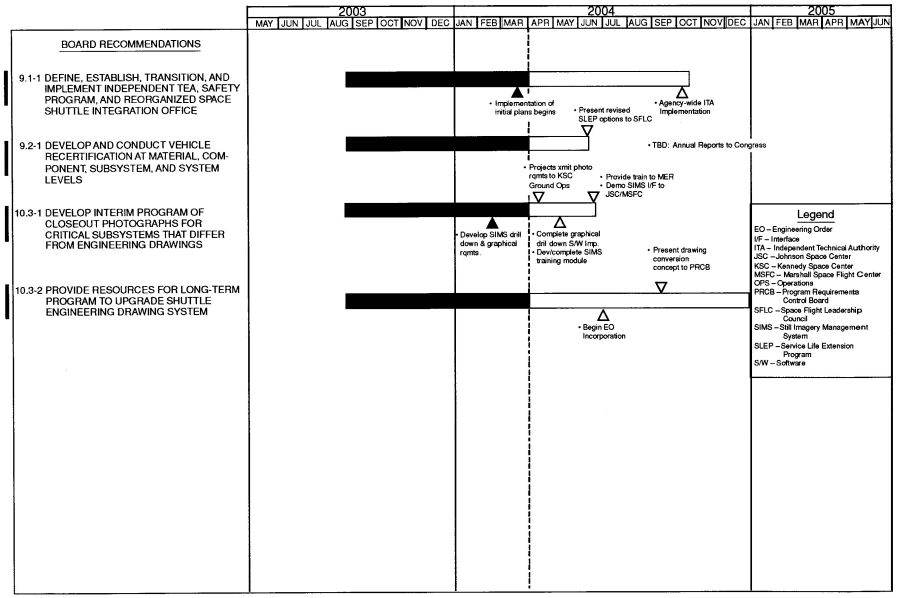
CAIB Recommendations Implementation Schedule



CAIB Recommendations Implementation Schedule



CAIB Recommendations Implementation Schedule



*Return to Flight Budget Estimates / Implementation Plan Map for Added Content and Improved Estimates

As of 5/27/04

5:30

($ millions)

FY 2005-2009 Under Review

**Recommendation #'s Map to Implementation Plan

		FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	Total	CAIB #3.2-1	CAIB #3.3-1	CAIB #3.3-2	CAIB #3.3-3	CAIB #3.3-4	CAIB #3.4-1	CAIB #3.4-2	CAIB #3.4-3	CAIB #3.8-1	CAIB #4.2-1	CAIB #4.2-3	CAIB #6.2-1	CAIB #6.4-1	CAIB #7.5-1	CAIB #7.5-2	CAIB #9.1-1	SSP Recommendation
	Initiated RTF Activities	92	264	238	177	166	67	76	1079																	
RE/AC	Orbiter RCC Inspections & Orbiter RCC-2 Shipsets Spares	4	21	30	30	30			115		O							O				O				
RE	On-orbit TPS Inspection & EVA Tile Repair	46	53	48	30	13			190													O				
RE	Orbiter TPS Hardening	4	17	47	45	46			160			O														
	Orbiter Certification / Verification	2	3						5		O		O	O												
RE	External Tank Items (Camera, Bipod Ramp, etc.)	26	60	45	30	30	30	30	251	O					O	O	O			O						
RE	SRB Items (Bolt Catcher, ETA Ring Invest., Camera)	0	14	13	7	4	1	1	40							O	O		O							
RP	Ground Camera Ascent Imagery Upgrade	8	36						44						O	O	O									
RE/AC	Other (System Intgr. JBOSC Sys, SSME Tech Assess, Ground Ops Workforce)	2	60	55	35	43	36	45	275		O		O	O							O					O
RE	**Stafford - Covey Team**	2	1						3																	O
(1)	**Total SSP RTF Activities**	94	265	238	177	166	67	76	1082																	
		(2)	(3)																							
	***Other RTF Related**																									
	NASA Engineering and Safety Center (NESC)		45	77	93	95	96	97	503														O	O	O	

O = Open C = Complete

RE = Reestimated Item (on 11/19/03 list); AC = Added Content

(1) The "Total SSP RTF Activities" budget line identified above represents an update to the estimates reflected in NASA's letter to the Committees dated November 19, 2003. This update includes added scope of work and improved estimates. Although there is a greater level of technical maturity, requirements are still evolving, the cost estimates for those activities are dynamic, and are still under evaluation to confirm the estimated cost and associated out year phasing. The Congress will be kept informed as we refine these requirements and associated cost estimates.

(2) The updated FY 2003 RTF estimate of $94M was included in an update to NASA's FY 2003 Operating Plan dated March 10, 2004; all of these activities have been approved for implementation.

(3) The updated FY 2004 RTF estimate of $265M includes $124M in activities that have been approved for implementation; the $124M in approved items was included in the initial FY 2004 Operating Plan dated March 10, 2004. The remaining $141M of RTF activities is still under review. Program control board action is underway and many of the changes have received technical approval. Efforts are in progress to determine sources of funding, as well as costs for recently identified activity above the $141M. NASA will notify the Committees regarding sources of funds for the $141M and whether costs for total FY 2004 RTF items changes.

Additional Notes:

*These estimates could change due to improved estimates, including reserves, additional tasks and added scope as we better understand the implementation of RTF recommendations. Also, these estimates do not capture analysis activities being absorbed in the Shuttle Program.

**This is a subset of current items being addressed at this time; all RTF recommendations will eventually be addressed, although each item may not require funding.

***NASA Engineering and Safety Center (NESC) is funded through NASA's Corporate G&A.
The NESC at the agency's Langley Research Center in Hampton, Va., provides comprehensive examination of all NASA programs and projects. The center provides a central location to coordinate and conduct robust engineering and safety assessment across the entire agency.

NEW TECHNOLOGIES

Senator MIKULSKI. Alright. That's terrific.

Now, this also goes to Senator Bond. One of the things that I think we both admire about NASA is not only the exploration of what's out there, but the invention of technology, the new ideas that then lead to new products, that also benefit the larger American community. We come up with new products, we're more competitive, we have jobs.

As you're looking at the development of a new vehicle, we'll call it the crew exploration, is that part of the intent to be looking at these whole new concepts like nanotechnology, et cetera?

And along the way, do you anticipate that this will accrue to our knowledge to, No. 1, aeronautics because we're competing with Airbus? No. 2, new kinds of materials, because won't they have to be lighter, more resilient, in order to be able to go out there?

Mr. O'KEEFE. Absolutely.

Senator MIKULSKI. Whenever we go?

Mr. O'KEEFE. Absolutely.

Senator MIKULSKI. And is this part of the thinking that along the way to getting to Mars, when we get there, that part of this will be the inventing of new technologies, new products, new materials?

Mr. O'KEEFE. Yes, ma'am. Absolutely.

Senator MIKULSKI. New ways of monitoring the health of the astronauts as they go?

Mr. O'KEEFE. Positively. That's precisely it. Again, so much of what drove the President to select this configuration for the vision statement, for the strategy, for the Presidential directive, for the first time ever it has got that level of detail to it, is an assumption of that technology development that's going to advance our capabilities to do this.

Absolutely that is the intent. That's how we're proceeding. Part of what the Aldridge Commission is going to be working with is the challenge of thinking about implementation strategies to achieve that precise outcome. So we're looking forward to their input as to how they're going to do that. And we're due to receive that by this summer.

Senator MIKULSKI. Well, Mr. Administrator, what I see is not competing visions. But competing demands for revenue.

I believe the vision is an exciting one, it is what has excited humankind every since Icarus tried to go, and why the Wright Brothers got off the ground a hundred years ago. And why we had our first launch to the Moon in 1968, et cetera.

So the vision is exciting. The idea of inventing new technologies and products which will benefit both our country and mankind is exciting.

And then, we have here the challenges of completing the work that we have, which is specific, immediate, and achievable. The International Space Station, the future of Hubble. So we see that what we have here is not a competing vision, but very serious stresses on the NASA program.

And, what concerns me with the President's recommendation and vision is that there is not enough money to do it. And what is being

proposed in the President's budget would enable us to stay the course, and work with you for a return to flight.

But I think this is going to have very serious challenges. And also, we're going to have to look at the consequences of deferring new space and earth science missions, freezing spending, eliminating research, these are pretty tough choices.

Mr. O'KEEFE. Oh, I agree, Senator.

It is and I think that two things apply here. The first one is that with this strategy, it is about priorities and which focus do we want to take to them. That is not to say that the research and activities that may not be of the highest priority to support this are irrelevant. But it, nonetheless, has to be focused towards these activities, lest it becomes maintenance of status quo.

Secondly, I would seek and I hope to convince you at some point, yes, this is affordable. Yes, what is in this resource base is what the President, the administration, believes is necessary to build on these technologies and do these things. Along the way, it's based on achievement of success and an adjustment thereafter, as opposed to some crash program that is designed towards some final solution at the end of the day.

So it is an approach I think that lays out very methodically that journey, not the race, that's necessary in order to achieve these. But at the same time, our abilities to achieve those outcomes along the way and see the results as we move along, to accomplish that.

In the process, I think it is revectoring some of those capabilities towards specific goals as opposed to for its own sake. What we're really trying to do here is put more focus to it.

SPACE SCIENCE DEVOTION

Senator MIKULSKI. Mr. Chairman, I have other questions that I will put into the record.

But I think we have covered a lot today. And I look forward to more conversations with you. And again, I want to thank you for the courtesies that you have extended to me, personally, and to all who were concerned about Hubble.

We can't do space science without our astronauts and we know that. So we're always on the side of the astronauts.

Thank you.

Mr. O'KEEFE. I appreciate that, Senator. If you would permit me to, Mr. Chairman, I have got a short paper, Senator Mikulski—we had talked about this too—that kind of outlines the rationale, as well as, the considerations that go into the servicing missions. I would like to insert that for the record, that does define them.

Senator BOND. Without objection. We welcome it.

[The information follows:]

CANCELLATION OF THE FIFTH (SM–4) HUBBLE SERVICING MISSION

EXECUTIVE SUMMARY

The Hubble Space Telescope (HST) was originally launched aboard the Space Shuttle in 1990, with an as designed mission lifetime of 15 years. Since then the telescope has been serviced or upgraded four times, each requiring a very complex, dedicated Space Shuttle mission and unique HST servicing support equipment. Even before its repair mission in 1993, the HST had generated significant scientific discoveries. The science return from HST has already vastly exceeded the original expectations.

NASA plans continued operation of the HST until it can no longer support scientific investigations anticipated to occur in the 2007–2008 time frame. The telescope's life may, in fact, be extended if NASA is successful in employing operational techniques to preserve battery and gyroscope functions. Meanwhile, NASA is aggressively investigating innovative ways to extend the science lifetime of the HST for as long as possible, including robotic servicing to provide extension of power storage. Current plans are to safely deorbit the HST by a robotic spacecraft by approximately 2013.

Although the HST deployment mission and four subsequent servicing missions were successfully conducted, the Columbia tragedy underscored the inherent risk in each and every Space Shuttle mission and reinforced the need for increased ability to deal with all potential contingencies, particularly catastrophic damage to the Orbiter's thermal protection system (TPS).

Without the benefit of docking at the ISS many new tools, processes, and techniques would be required for inspection and possible repair of the TPS. More significant would be the requirement to dedicate two Space Shuttles to the mission to ensure astronaut safety. In the event of a significant problem with no safe haven for the astronauts to wait as in ISS missions, a second Shuttle would have to be launched and employ untried and uncertified techniques to perform a rescue. Hence, a Shuttle based HST servicing mission presents known additional risks, and offers few options to respond to serious problems in orbit.

Recognizing the increased risks involved in all Shuttle flights following the tragic loss of the Columbia and crew NASA elected to reduce its planned Shuttle manifest to only missions to the International Space Station (ISS). The decision was also made, on the basis of risk, to not pursue a final servicing mission to the HST, but instead to investigate other options to extend the life of the Hubble.

COLUMBIA ACCIDENT INVESTIGATION BOARD FINDINGS AND IMPACT ON FUTURE MISSIONS

The Columbia Accident Investigation Board presented NASA with 29 recommendations, 15 of which were required to be completed before the Space Shuttle could return to flight. Highlights of these flight-critical recommendations included elimination of damaging insulation shedding from the external tank—the cause of the Columbia tragedy—ascent imaging, on-orbit inspection, and thermal protection system tile and Orbiter leading edge repair. NASA will satisfy all of these recommendations before it launches STS–114, the next Shuttle mission. The Board stressed that the Space Shuttle is still a developmental vehicle and that risk and risk mitigation must be treated accordingly. NASA's original vision was to fly the Shuttle to mid-decade or 2020 for a total of 75–80 more flights. NASA fully accepts the Board's recommendation and balancing mission criticality against possible loss of crew and vehicle, consciously decided to retire the Space Shuttle after the completion of the International Space Station (ISS), recognizing that the best risk mitigation strategy is to fly less.

In addition, NASA realizes that a "safe haven" in space capability is required. This "safe haven" capability goes beyond compliance with the Columbia Accident Investigation Board recommendations and is designed to increase crew safety during the remaining Space Shuttle missions. Should damage occur to the Shuttle thermal protection system that can not be repaired and that would preclude safe reentry, the crew will be able to shelter at the ISS until another vehicle can be readied for rescue. Agency policy will require each Space Shuttle mission to have backup rescue capability. "Safe haven" is the ultimate recognition that, while NASA will make the Space Shuttle as safe as possible, the Columbia tragedy has taught us that there are still significant risks inherent in Space Shuttle launch, orbit operation, and reentry.

UNIQUE REQUIREMENTS AND INCREASED RISK IN THE HUBBLE SERVICING MISSION

Whereas tools, techniques, and procedures would be similar on each ISS mission; e.g., inspection, thermal protection system repair, safe haven readiness, and rescue scenario, an HST servicing mission would have unique requirements, both on-orbit and in ground processing. Options for dealing with an on-orbit emergency are reduced and decisions for reacting to any emergency would have to be made quickly. These two considerations, and the attendant schedule pressure on the flight crews and support teams, add considerable additional risk.

Lack of Significant Safe Haven

The areas of additional risk relate to the ability to provide "safe haven" while inspection, repair and potential rescue are undertaken, and to the procedures for in-

spection and repair themselves. It has been projected that a typical Space Shuttle flight crew of seven astronauts could stay aboard the ISS for up to 90 days, if warranted, due to an emergency situation on the Space Shuttle. This safe haven capability allows the flight crew and ground teams to consider all options, determine the best course of action, take the time required to understand the cause of the failure and affect repairs, or send the appropriate rescue vehicle with the right equipment to bring the crew home. Clearly, rushing this process would introduce considerable new risk and in the worse case result in the loss of another vehicle.

In the case of a Hubble servicing mission, the amount of stay time on orbit is significantly shorter due the limited stores of cryogenic oxygen on the Orbiter. Therefore, other measures would be required. Specifically, a second Space Shuttle on an adjacent launch pad would have to be specially prepared, uniquely configured to launch expeditiously if required to perform a rescue mission. This scenario raises several concerns, addressed in the paragraphs below.

Unprecedented Double Workload for Ground Launch and Processing Teams

Two vehicles would be processed for essentially the same launch date. Any processing delays to one vehicle would require a delay in the second vehicle. The launch countdown for the second launch would begin before the actual launch of the first vehicle. This short time period for assessment is a serious concern—it would require a highly complex process to be carried out in parallel, and it would not permit thorough assessment by the launch team, the flight control team, and the flight crew.

No Changes to Cargo or Vehicle Feasible

Because of the very short timeframe between the launch of the first vehicle and the requirement for a rescue flight, no significant changes could reasonably be made to the second vehicle or the cargo. This means that it would not be feasible to change the cargo on the second Space Shuttle, to affect a repair to the first Shuttle, add additional rescue hardware, or make vehicle modifications to avoid whatever situation caused the need for a rescue attempt in the first place. Not having sufficient time to make the appropriate changes to the rescue vehicle or the cargo could add significant risk to the rescue flight crew, or to crew transfer. The whole process would be under acute schedule pressure and undoubtedly many safety and operations waivers would be required.

Rescue Mission

Space Shuttles routinely dock with the ISS; Soyuz evacuation procedures are well trained. These represent the normal operations mode today supported by extensive training, analysis and documentation. A rescue from the ISS, with multiple hatches, airlocks, and at least one other vehicle available (Soyuz), is much less complex and risky than that required by a stranded Space Shuttle being rescued by a second Space Shuttle.

In response to a question by the Columbia Accident Investigation Board, NASA analyzed a hypothetical rescue mission between two Space Shuttles and found that the effort would have required many unproven techniques, such as emergency free-space crew transfer in space suits while performing Space Shuttle to Space Shuttle station-keeping while traveling 17,500 mile per hour above the earth. These major safety risks are not incurred during rescue from the ISS.

Tile Survey (Expanded Inspection Requirements) and Thermal Protection System Repair

The current inspection method for acreage tile, gear door seals, and the elevon cove is to photograph these areas from the ISS during rendezvous. To support an HST servicing mission, NASA would have to develop a new method for inspecting these critical areas using an Orbiter boom. Unvalidated autonomous boom operations represent an unknown risk. NASA's current planned TPS repair method for an ISS-based repair uses the ISS robotic arm to stabilize an EVA crew person over the worksite. These assets are not available for an HST servicing mission, so NASA would have to develop a single-use alternate method for stabilizing the crewmember. This method would have to provide greater stability than the current ISS option under development to protect both the crewmember and the other TPS areas from additional damage. Such a concept represents a challenging undertaking, which could take months or years to develop in order to meet safety and mission assurance standards/requirements.

RETURN TO FLIGHT AND ISS U.S. CORE COMPLETE TIMELINE

In the process of addressing the Columbia Accident Investigation Board recommendations and implementing additional improvements to achieve the safest

flight possible, NASA has uncovered a number of problems that had previously gone undetected. The removal and replacement of unsafe hardware has deferred Space Shuttle launch milestones. NASA projects the first opportunity for a Space Shuttle launch to the ISS to be in March 2005. Eight flights are scheduled to meet our international commitments, the assembly of the U.S. core segments of the ISS. Given the ISS assembly schedule, the earliest NASA could launch a servicing mission to the HST, based on requirements for daylight launch to fully assess ascent conditions by imagery and thermal constraints when docked to ISS, would be Spring 2007.

Based on the evaluation of the engineering data on the HST, the lifetime of the Observatory on orbit is ultimately limited by battery life, which may extend in to the 2007–2008 timeframe. Scientific operations are limited by gyroscope lifetime that is more difficult to predict. If all of the NASA effort is concentrated on a Shuttle servicing mission, every step in the process must be successful with no allowance for schedule slips. Before launch all of the recommendations of the Columbia Accident Investigation Board must be met. The launch conditions must be perfect, and all tailored HST mission unique components must be in place with very tight schedule constraints. If any of the many elements do not develop as planned, the telescope may cease operations before a successful mission could be mounted.

HUBBLE SPACE TELESCOPE'S SCIENTIFIC LEGACY

Not since Galileo turned his telescope towards the heavens in 1610 has any event so changed our understanding of the universe as the deployment of the Hubble Space Telescope. From its orbit above Earth's atmosphere, the HST is free from the atmospheric turbulence that all ground-based telescopes must contend. Thus, HST has been able to return images of astounding clarity and sensitivity. HST imaging and spectroscopy have resulted in remarkable scientific achievement, including the determination of the changing rate of expansion of the universe and detailed studies of forming galaxies, black holes, galaxy hosts of gamma-ray bursts and quasars, active galactic nuclei, protostars, planetary atmospheres, and the interstellar and intergalactic medium. Scientific results have significantly surpassed original expectations. By 2005, the HST will have fulfilled every one of its scientific objectives and top-level technical requirements. Moreover, the Hubble will continue to collect observations for several more years. Even after the HST is no longer in service, the rich archive of HST data (already more than 100,000 observations of 20,000 unique targets) will continue to provide new discoveries for the years to come, with full support by NASA for both archive operations and research grants.

FUTURE PLANS FOR HUBBLE SPACE TELESCOPE AND ASTRONOMY

Astronomy is a critical part of the NASA's exploration initiative. NASA is aggressively investigating innovative ways to extend the science lifetime of the HST for as long as possible, including a possible robotic servicing option. We are receiving several responses to our recently released Request For Information (RFI) on HST End of Mission Alternatives soliciting concepts for robotically-provided battery power extension. Indeed, this option appears to have greater likelihood of success than the possibility of accomplishing all the recommendations of the Board in time for a successful Hubble servicing mission.

HST is not NASA's only portal to the stars. It is one of many telescopes used by astronomers to study the universe using various apertures and wavelength bands. Hubble, primarily used for observations of visible light, is one of the four orbital "Great Observatories" designed for use across the spectrum. The other three include the Compton Gamma-Ray Observatory (1991–2000), the Chandra X-Ray Observatory, and the infrared Spitzer Space Telescope. In the years since Hubble was launched with its 2.4-meter aperture, many new ground-based telescopes have been built with larger apertures that enable observations with increasingly higher angular resolution, though subject to the blurring effects of Earth's atmosphere.

The James Webb Space Telescope (JWST) program has been strengthened to assure a 2011 launch date. Once on orbit, this advanced technology infrared telescope will provide insight into the a region of the spectrum where we will be able, like never before, to view the formation of the earliest galaxies. The JWST will build on the successful science of the Hubble via the most advanced instrumentation and a larger 6.5 meter aperture.

The following table lists larger optical telescopes now or soon to be available along with Hubble and also several examples of large telescopes available or in development for observations at other wavelengths.

EXAMPLES OF LARGE TELESCOPE FACILITIES AVAILABLE OR IN DEVELOPMENT

Radio/MM	Infrared	Optical + IR (aperture, meters)	Ultraviolet	X-Ray	Gamma Ray
VLA	Spitzer	SALT (11.0)	HST	Chandra	GLAST
GBT	SOFIA	Keck I, II (10.0)	GALEX	XTE	SWIFT
ALMA	JWST	Hobby-Eberly (9.2)		XMM-Newton	
Arecibo	HST	LBT (8.4 x 2)		Astro-E2	
FCRAO		Subaru (8.3)		SWIFT	
VLBA		VLT (8.2 x 3)			
CSO		Gemini (N & S) (8.1)			
		HST (2.4)			

The HST program has provided a significant amount of funding support for U.S. astronomers; in fact, it is currently providing approximately 20 percent of all direct grant support. After HST observations have ceased, NASA plans to continue to support ongoing grants and to offer new grant support for HST archival research until a similar grant program is in place for the upcoming James Webb Space Telescope program. This will ensure stability to the research community and full use of the rich HST data archive throughout this period of transition.

CONCLUSION

The cancellation of HST–SM4 was a difficult decision. HST is producing world-class science. However, NASA cannot justify the additional risk that such a unique mission would entail, based on what must be done to assure greatest protection to the crew. It is increasingly apparent that our choice is to either fully comply with the Columbia Accident Investigation Board report or conduct the servicing mission, but not both. We must be responsible on all future flights and be fully compliant. NASA will continue to aggressively pursue options to extend the science lifetime of the Hubble by means other than Shuttle servicing. NASA will continue to be a major supporter of astronomy in the future as the Agency continues to explore the universe.

Mr. O'KEEFE. We appreciate it very much, Mr. Chairman. Thank you.

Thank you, Senator for your courtesies as well. I appreciate that.

SHUTTLE RETIREMENT

Senator BOND. Mr. Administrator, as my colleague from Maryland has indicated, we're not just going to keep the record open for further questions. This is just the beginning of a dialogue because these questions are very serious, they're very extended.

I want to step back. I am still concerned about the retirement issue. In the fall of 2002, NASA said that they were going to continue operating the shuttle until 2015 or perhaps 2020. Now, with the CAIB report, saying that the shuttle must be recertified by 2010. And the costs there, I see this as the deadline to retire the shuttle.

But I am concerned, given the reality that ambitious schedules are almost never met by NASA or any other entity on the cutting edge of technology and science.

Are we going to be tempted to force more missions in to get the space shuttle, to get the International Space Station fully established by 2010 as the President indicated? Are we going to be taking or running too many missions at a risk?

If the shuttle has to be flown past 2010, due to possible schedule slips, or the unavailability of either other international partner vehicles, or commercial vehicles, what would be the costs of recertifi-

cation of these shuttles? What are the fall back numbers and prospects?

Mr. O'KEEFE. Yes. I appreciate it, Mr. Chairman. The approach we've taken in this strategy, which is clearly enunciated in the President's directive, is to complete the International Space Station. Senator Mikulski, both you and the Chairman have enunciated it here. Our objective is to minimize the number of flights necessary to achieve that task. Because that's a driving philosophy that does that. You're right, Mr. Chairman. The approach we used a year and a half ago, of looking at service life extension, was to try and operate the shuttle for as long as we could sustain its service life. The Columbia accident changed all of that.

It opened everybody's eyes to what the risks are of doing this. It is not an operational vehicle. It's an experimental one. It will be experimental to its last flight and last landing when it's retired. That milestone, not date, that milestone will be the completion of the International Space Station. The President's directive is very clear on that. Our task is to try to achieve that by the end of this decade. Based on the flight manifest, if we're able to return to flight in a timely manner here, next year, we can achieve that without a break-neck schedule that would be required to do that.

What we're working with our international partners on right now is developing exactly what are the modules and components that we absolutely intend to deploy to get the full science yield and research capability out of the International Space Station for years to come. That's what is going to drive our considerations rather than the calendar.

Senator BOND. Well, will the Columbia Accident Investigation Board report based on 2010 as the time we needed the recertification, or was it based on a certain number of flights that the shuttle would take before it would need to be recertified?

Mr. O'KEEFE. Okay.

Senator BOND. I mean, you got two different numbers.

Mr. O'KEEFE. Right.

Senator BOND. We're going to retire it in 2010, but then we're not going to retire it until we complete the space station.

Mr. O'KEEFE. Right.

Senator BOND. What is the driving deadline—when the Columbia Accident Investigation Board said we had to recertify the shuttle?

Mr. O'KEEFE. Thank you, Mr. Chairman.

I am not aware of what drove the Columbia Accident Investigation Board to pick an arbitrary date. If anything, I found it kind of baffling.

Senator BOND. Maybe we should seek some clarification on that, because is time wearing it out? Is the number of flights wearing it out?

Mr. O'KEEFE. Oh, I would——

Senator BOND. Do we need to have more flights? I mean, there are some questions here that need to be addressed.

Mr. O'KEEFE. Sure. But the approach that we're using, rather than trying to delve into what may be in the psyche of 13 members and why they picked that date——

Senator BOND. No, not psyche. But what was that reason?

Mr. O'KEEFE. I understand.

Senator BOND. Foundation?

Mr. O'KEEFE. The approach we've taken to it is what big milestones have driven this, and that's the completion of the International Space Station. We believe we can do that by the end of this decade.

I will know a better answer to that once we have convened with our international partners to look at what that final configuration looks like. That then tells me how many flights you actually have to conduct. Based on the preliminaries here, we're not talking about a number that is going to surprise anybody. We're looking at something in the range of, certainly 20 to 30 flights is the maximum number that could be obtained in that time. That outer edge is really larger than what we might have anticipated. So, we'll know the answer to that one a lot better once we get the final configuration in place. And that's what the President's directive is to do.

The certification question is something that we're going to have to enjoin at some point to figure out whether or not that butts up against the milestone objective of completion of the station.

ALDRIDGE COMMISSION

Senator BOND. We've talked about the Aldridge Commission. If it turns out that the Aldridge Commission has recommendations that contradict what NASA is asking for in fiscal year 2005, are you going to come back to us, or are you doing some back channeling? Are they going to be on target with your recommendations? Or what happens if we get a surprise?

Mr. O'KEEFE. I don't anticipate a surprise. In every discussion that I've heard that the Commission has engaged in, their terms of reference, if you will, the charter that the President gave them, is to go out and look at implementation strategies. One of the earliest understandings that I have had with all of the commission members is that the way this particular strategy has been developed, it gives us ample opportunities to make adjustments based on successes as we move along, rather than some finite set of goals that must be achieved by date certain. So I don't see a lot of daylight in terms of what approach they will take.

What I do see from them is a lot of creative ideas about how we should go about implementing this, as it pertains to commercial and industry involvement, what degree of international participation and how we should do it, acquisition strategies on the spiral development that I talked about a little bit.

There is a whole range of things that they've put in their "to do" list, if you will, that I think is going to help inform us how to implement this properly, efficiently, and at affordable costs. So I don't see a lot there. And we're spending a lot of time engaging with them on their findings thus far.

VISION FOR SPACE EXPLORATION

Senator BOND. Okay, let me ask one last question that concerns all of us. I think we have touched on it a number of ways. Both Project Prometheus and implementing that new NASA vision, are going to consume lots of funds in the next 5 to 10 years. Prometheus itself could cost $3 billion over 5 years.

And the vision is obviously redirecting a whole slew of funds with large known program costs, and other costs uncertain. How is NASA going to fund the many opportunities that present themselves in the future that fall outside the vision. They've already been raised.

Senator Shelby mentioned material science. Senator Mikulski and I are very concerned about that. We're also concerned about Hubble. Is NASA going to be unable to continue commitments to current activities to meet these goals?

We're going to have some real squeezing out on some things that we think have been very vital scientific breakthroughs by these two major projects. What's your thought on those?

Mr. O'KEEFE. Thank you, Mr. Chairman. My thinking is that the President's direction and vision that he has articulated is completely in line with the directions we're moving, in terms of what our mission requirements are for the agency. If anything, it clarifies. It defines what it is we should be doing with much greater precision.

So it is not here are all of our mission objectives and here is another thing glued on top of it. It is very much in concert with the direction we're going, and lends greater precision to what that result should be. In many ways his direction answers some of the broader questions. Part of what we're intent on doing is integrating those capabilities. To assure that it is not what is inside and what is outside the vision objectives. It is what is within our mission to go carry out this strategy. And how do we employ that best.

So along the way, to the extent that there are adjustments required in order to better fulfill that objective, or to meet other mission requirements of the agency, we intend to do that full range approach of an integrated direction of where we're headed.

I don't see things falling outside of it. There are priorities. There are going to be differences on that. On the sciences, for example, no question understanding the expeditionary nature of long term space flight, power generation requirements and so forth, are the kinds of things that we must do if we're going to obtain this broader strategy objective. But that's fully in concert with what the mission of this Agency should be, and that's greater clarity than we've had in at least a couple of decades.

Senator BOND. Well, Mr. Administrator, thank you very much for your time and for your exposition of the vision and how you're going to meet it.

I will have quite a few questions for the record about the cost of the Moon/Mars vision, the international partners, and a number of other things.

And as I said, there are quite a few things on which we're going to need to follow up with you, and continue to work with you as we try to figure out how we can get the job done with what. Frankly, it looks like inadequate resources from here. I am hoping we can find the resources to carry out all of these wonderful things.

But looking at the budget and what we're seeing, as available for this committee, I am very much concerned.

Senator Mikulski, any closing thoughts?

Senator MIKULSKI. I know that we're going to be having an ongoing conversation. I'll just put out some flashing lights. No. 1, in

terms of the replacement for the shuttle, it has been, and I caution you that it's been the history of NASA to over promise both in terms of what it can deliver, when it can deliver, and when it could deliver it.

We watched the development of the shuttle. Again, it was going to be the answer to everything, and it's been a remarkable vehicle. But at the same time, it was over promised, over budget, et cetera. Just know that's what we worry about.

Mr. O'KEEFE. I do, too, Senator.

Senator MIKULSKI. The second thing that I think that applies to this is that impact on personnel and morale.

Senator Bond and I are very concerned about the fact where are the scientists and engineers coming from, and how to get young people excited in this. But if they devote their whole life preparing for research in a particular area, then all of a sudden things start to be cancelled because of budget or shifting priorities, that is going to have an impact.

But we know that NASA faces aging technologies and an aging workforce. And we're interested in where are you going to get what you need when you need it, but we're concerned that shifting sands could have a negative impact on morale.

These are things for additional conversations, but I think that we've covered the core issues today.

ADDITIONAL COMMITTEE QUESTIONS

Mr. O'KEEFE. If I could very quickly, Senator.

I want to thank you and the committee and the Senate for enacting the Workforce Flexibility Act just here a month ago for NASA. That's a big advance. S. 610 is going to help us to achieve and conquer the kinds of challenges that you've talked about. That's a very, very significant move forward and we appreciate the support of that.

[The following questions were not asked at the hearing, but were submitted to the Administration for response subsequent to the hearing:]

QUESTIONS SUBMITTED BY SENATOR CHRISTOPHER S. BOND

IMPLICATIONS FOR TERMINATING THE SHUTTLE PROGRAM IN 2010

Question. At this time, the shuttle is the only U.S. vehicle capable of taking astronauts to and from space. Under the new vision for NASA, the shuttle would be retired when space station construction is completed in 2010. A new Crew Exploration Vehicle would be developed and fully operational for Earth orbital missions by 2014.

What would be the consequences of a 4-year, and possibly longer, hiatus in U.S.-flown human spaceflights?

Answer. NASA expects to utilize the ISS through at least 2016. Following retirement of the Shuttle upon completion of ISS assembly, NASA envisions using a combination of vehicles from Russia, the European Space Agency, Japan, and potential commercial initiatives to deliver crew and cargo to the ISS. Currently, NASA anticipates that using these vehicles instead of the Shuttle will limit cargo return and may restrict the size of certain logistical re-supply elements. The ISS operators and users are currently evaluating each of these limitations in order to ensure ISS productivity is maintained during this U.S. transition period in space transportation. The retirement of the Shuttle fleet would allow the Shuttle's resources to be redirected to support other human spaceflight and exploration activities necessary to achieve the goals of the Vision for Space Exploration.

Question. How much would Russia charge for taking U.S. astronauts to and from ISS, and how would NASA pay for such services given that the Iran Nonproliferation Act prohibits NASA from paying Russia for ISS-related activities?

Answer. We have not discussed this issue with Russia. We are aware of the provisions of the Iran Nonproliferation Act, and the administration will work with Congress to resolve issues related to ISS support, as necessary.

Question. Would China be considered as an alternative now that it can launch people into space?

Answer. The new Vision for Space Exploration directs NASA to consider foreign and commercial options for servicing the ISS. No options have been selected or ruled out for either crew transfer or cargo at this time.

Question. What upgrades to the shuttle should NASA continue to pursue? What new launch vehicle, or vehicles, may need to be developed?

Answer. NASA will continue to pursue Space Shuttle upgrades to systems mitigate risks and assure safe flight as we complete assembly of the International Space Station. The Space Shuttle Service Life Extension Program (SLEP) is the current vehicle for determining these upgrades, and its focus will transition to safety and reliability initiatives. The SLEP team is currently working to review and prioritize upgrades in light of the Vision for Space Exploration. NASA will look to the Office of Exploration Systems to determine new launch vehicles requirements to support the Vision for Space Exploration.

WORKFORCE INVOLVED WITH HUMAN SPACE FLIGHT

Question. What will happen to this skilled workforce as the shuttle program ends?

Answer. NASA's contractors have the requirement to hire appropriately skilled personnel or train them to meet all the conditions of the contracts. They have been hiring or training to meet and maintain our skill level requirements, and this trend is anticipated to continue. As the Space Shuttle program nears retirement, we fully anticipate that aerospace technician employment opportunities will continue after completion of ISS assembly, with NASA, driven in part by the Vision for Space Exploration and the continuing need to support the International Space Station.

Question. How can we guarantee that as workers begin to leave an ending program for other activities that the final flights will have the same amount of associated risk?

Answer. NASA understands the challenges of maintaining an enthusiastic workforce as the Space Shuttle program phases down. We are beginning to develop a plan to ensure that the skills required to maintain a safe and reliable fleet are in place until the last Space Shuttle flight has completed its mission.

Question. How will NASA retain the skills necessary for human space flight while the country's space program is taking a flight hiatus for at least 4 years?

Answer. The retirement of the Space Shuttle is not the end of the space program but rather the beginning of an opportunity to transition a highly skilled workforce into programs requiring their skills and challenging their creativity. We believe, at the appropriate time, these workers who have Shuttle experience will be able to continue work with NASA on new programs requiring their unique skills.

FUNDING OF ISS RESUPPLY MISSIONS

Question. What is the status of discussions with the other International Space Station partners regarding how to fund Russian production of a sufficient number of Progress cargo spacecraft to keep the space station operating while the shuttle fleet is grounded?

Answer. To date, FKA has continued to fully support ISS operations based on additional Russian government funding. On November 13, 2003, Russian Prime Minister Kasyanov authorized a 1.5 billion ruble (approximately $50 million) budget supplement for FKA to meet ISS operational needs. In the context of the overall Russian Federal Space Budget for 2003, this supplemental was a 19 percent increase in spending authority. The 2004 Russian Federal Space Budget included a 20 percent increase (over the supplemented 2003 figure) to the ISS budget line.

Question. Will the other partners be able to provide the needed funding, or do you expect that you will need to ask for a waiver from or amendment to the Iran Nonproliferation Act so that NASA can provide some of that funding?

Answer. We are discussing all aspects of the future configuration and support of the ISS with the partners at this time. No decisions have been reached.

TIMELINE FOR ENHANCE USE LEASE

Question. In 2003, we provided NASA with the ability to enter into EULs. The EUL authority was an issue that NASA had wanted for all of the centers but was

limited to two centers in order to see how NASA would utilize this authority. I am interested in the progress of the selection process, and how this new authority has been utilized.

Can you please give me an update on the status of this program, and any insight as to the infrastructure needs at NASA centers that have become known because of the selection process?

Answer. Public Law 108–7, the fiscal year 2003 Omnibus Appropriations Bill, authorized NASA to conduct a demonstration program for Enhanced Use Leasing (EUL). Congress limited the demonstration program to two (2) NASA Centers. NASA conducted a formal process to select the 2 demonstration sites. All NASA Centers were requested to submit detailed proposals to include a description of the purpose and marketing potential of the property(ies), a description of the lease(s) including the proposed term(s), and a description of the value to Center. The selection criteria were also sent to all NASA Centers, and included overall benefit to Center, overall value of the business plan to NASA, opportunity for success, including the readiness of the EUL projects, and marketability of the property(ies).

Six NASA Centers submitted proposals. All six proposals exhibited significant merit and benefit to NASA. The proposals were evaluated and ranked by a panel consisting of NASA Headquarters planning and real estate specialists and a real estate specialist from the General Services Administration. The rankings were reviewed and approved by the NASA Headquarters Institutional Committee and Executive Council. Through this process, the Kennedy Space Center (KSC) and the Ames Research Center (ARC) were selected as the EUL demonstration sites in July 2003.

In the period since the selection of the two demonstration sites, NASA Headquarters has worked closely with KSC and ARC to develop EULs. This is a new initiative for NASA, and we have proceeded cautiously and meticulously.

As of April 2004, ARC has executed 17 small EUL agreements for an approximate total of $300,000 anticipated annual revenue, which includes monthly rent and common service charges for support services provided by the Center. These leases are short-term (1–5 years). They include a lease of the existing NASA fuel storage and distribution system, a lease of building space for research and development of commercially viable fuel cells, leases of historic buildings for education and research, and leases of office and laboratory space for nanotechnology research. KSC has developed an out lease of Center land for use by a telephone service provider (Verizon) to place a trailer and a cell tower to enhance Verizon cellular telephone service across the Center. This KSC lease has been approved but has not yet been signed.

A summary of planned activities for ARC and KSC follows:

ARC's NASA Research Park (NRP) is envisioned to be a privately-funded initiative to develop available under-utilized land at ARC into an active research park with tenants performing space- and aeronautics-related study and research. ARC completed a Final Programmatic Environmental Impact Statement and Record of Decision in November 2002 including the NASA Research Park. This was finalized before EUL was authorized for NASA. The NRP will be executed through an EUL land-use agreement. Several leases have been approved and entered into for tenants in the first phase of the NRP. These leases are for existing facilities that the tenants will use in their own research and development activities. ARC also has a wide variety of future proposals under consideration for implementation in fiscal year 2004, including:

—lease of an existing historic building with Clark University;
—leases of existing under-utilized office and laboratory space for the Nanostellar Corporation, and the Northern California Nanotechnology Initiative; and,
—potential long-term lease of land and existing buildings for a Training and Conference Center; Requests for Qualifications for prospective lessors was released in April 2004; response are due in May 2004.

KSC is working on the development of the International Space Research Park (ISRP). The ISRP will be developed by the Florida Space Authority (FSA) through an EUL agreement and Space Act agreement. The ISRP will develop approximately 400 acres of under-utilized land on KSC. The term of the EUL agreement is envisioned to be 50 years, with a 25-year option. The early stages of this effort have been focused on developing appropriate language for the operation of the EUL and assuring NASA receives proper fair-market consideration. KSC has also prepared a Draft Environmental Impact Statement (EIS), a key and necessary element for establishing the research park. The Draft KSC EIS was released for public review and comment through March 2004. NASA anticipates release of the Final EIS and Record of Decision later this spring. The EUL agreement is anticipated to be executed by December 2004.

KSC also anticipates a wide variety of future proposals, as existing leases for land at KSC expire and are converted into EUL agreements. These include: leases to

news and wire services for areas used to report on launches; and, leases of Center land for use by a telephone and communication service providers.

WEBB TELESCOPE

Question. The follow on to the Hubble Telescope is the James Webb Space Telescope. While this telescope it is not a true replacement of Hubble, it will continue the mission of looking back in time to some of the early events in the creation of the universe. This is the number one priority in this decade for the astronomy and astrophysics community.

What, if any problems are being encountered with the James Webb Space Telescope project that could affect its proposed launch date or achieving its scientific goals?

Answer. Currently, JWST is in the preliminary design phase (Formulation) and it faces no significant technical or budgetary problems. Progress toward an August 2011 launch is on-track and proceeding according to plan. The program has passed independent reviews of its conceptual design, its top-level requirements and most of its lower-level requirements. While JWST is a technically challenging endeavor, there have been no compromises in its baselined scientific performance or launch date.

ALDRIDGE COMMISSION

Question. As I mentioned in my statement, the President created the Commission on Implementation of United States Space Exploration Policy, or Aldridge Commission, to provide recommendations to the President on implementation. This commission will provide these recommendations in June of this year, yet NASA appears to be already making their plans ahead of the recommendations.

Once the recommendations are made, how will NASA address the recommendations if they contradict what NASA is asking for in fiscal year 2005?

Answer. NASA submitted its fiscal year 2005 Budget request earlier this year and took into account the President's vision in order to begin implementation as quickly as possible. There is sufficient flexibility in our planning to accommodate the advice of the Aldridge Commission, which we recently received.

Question. To what extent has there been communication between the Commission and NASA about what recommendations can be expected?

Answer. The Commission worked independently. NASA provided administrative support and responded to the Commission's requests for information and briefings. Some commissioners conducted fact-finding visits to NASA centers. The Commission did not provide recommendations to NASA: their recommendations were transmitted to the President as part of their report on June 16, 2004.

HUBBLE TELESCOPE

Question. A short time after the announcement of the President's exploration vision, NASA indicated that it would be canceling any further shuttle missions to Hubble. NASA has cited safety concerns as the primary reason for having an early end to the life of a truly amazing instrument.

In making the decision to cancel the SM4 servicing mission, did NASA perform a risk analysis in which the risks were quantified and evaluated rigorously? What tools were used to assess the risk involved, what were the results, and what alternatives were discussed? Aside from the plans for deorbiting Hubble, what are the plans for the fiscal year 2004 funding that would have been used for the SM4 servicing mission?

Answer. The decision to cancel the Hubble SM4 servicing mission was made after evaluating the requirements that came from safety recommendations of the Columbia Accident Investigation Board (CAIB) report. NASA rigorously examined the on orbit inspection techniques and repair methods that are required to ensure adequate mission safety. NASA determined that safe inspection techniques and repair methods could be developed for use on the Shuttle while docked at the International Space Station (ISS) because of the safe haven capabilities of the ISS and because the Space Station Remote Manipulator System (SSRMS) would be available to assist with inspection and repairs.

For the scenario of the Shuttle in a non-Station orbit (like the HST servicing mission), NASA determined that it would have to develop unique, single use technologies and tools in order to be able to accomplish the needed inspection techniques and repair methods. It is unlikely the new technology needed to service Hubble would be ready before critical Hubble systems fail (Gyroscopes will probably fail by late 2006; the battery is expected to fall below needed capacity in about 2008).

NASA would also have to dedicate two Shuttles for a servicing mission to comply with safety recommendations of the CAIB for a non-Station mission. NASA would need a second Shuttle positioned for launch, which would require an unprecedented double workload for ground crews. The rescue, if required, would involve a Shuttle-to-Shuttle crew transfer with unproven techniques. All this would have to be done under extreme schedule pressure, because Shuttle life support, food and water are limited. On a non-Station autonomous mission, the crew would only have 2 to 4 weeks before the rescue Shuttle would have to arrive.

NASA issued a formal "Request for Information" (RFI) on February 20, 2004, to solicit from industry academia or anyone who may have useful information bearing on how to extend the useful scientific lifetime of the Hubble. NASA received 26 responses, which are being evaluated at this time. A plan will be developed when a decision is made as to the approach the Agency will take to prolong the life of Hubble.

NASA has also formally requested a study by the National Academy of Sciences to ensure we have fully considered all reasonable alternatives to finding the best way to extend the lifetime of the Hubble Space Telescope.

SHUTTLE RETIREMENT AT 2010

Question. In the fall of 2002, NASA announced plans to continue operating the space shuttle until 2015, and perhaps to 2020 or beyond. Now the plan is to retire the shuttle fleet by 2010. A key component to making the President's vision affordable in the long term is the avoidance of a recertification of the fleet in 2010, which is called for in the CAIB report.

If the shuttle must be flown past 2010, due to possible schedule slips beyond those that have already happened this year, what would be the cost of recertification?

Answer. NASA is currently reassessing the ISS assembly sequence to ensure that the Shuttle can be safely retired following assembly of the International Space Station, planned for the end of the decade. To prepare for the contingency that the Shuttle may need to operate beyond 2010, NASA is assessing the need to recertify Space Shuttle systems, subsystems, or components consistent with the Vision for Space Exploration and in line with the recommendations of the Columbia Accident Investigation Board. The technical work required to determine when and if recertification would be needed will continue into this summer. Once the technical definition of the recertification tasks is completed, cost estimates will be developed on the items we need to recertify and made available for discussion.

Question. If the Moon/Mars goal is not adopted, or delayed significantly, what will the future be for the shuttle?

Answer. NASA has adopted the goal and objectives established in the Vision for Space Exploration, and is transforming itself to meet those objectives, and the Agency has revised its program accordingly. Consistent with the Vision for Space Exploration, NASA intends to phase out Shuttle operations following the completion of the International Space Station, planned for the end of the decade.

BIG PROJECTS CROWDING OUT OTHER RESEARCH

Question. Both Project Prometheus and implementing the new NASA vision are going to consume a large amount of funds in the next 5 to 10 years. By some estimates, Project Prometheus could cost $3 billion over 5 years, and the vision is causing a large redirection of funds for years to come.

With large known program costs, and other costs currently uncertain, how is NASA going to fund the many opportunities that may present themselves in the future that fall outside the vision?

Answer. NASA will continue to invest in priorities such as Aeronautics and Earth Science that may contribute to, but are not completely focused on, the vision for exploration. There are always many more opportunities than funding available, and NASA will continue to assess potential investments against priorities in the exploration vision and other important areas of our vision and mission. There is a natural turnover in projects as they are completed, and NASA will also continue to assess priorities for how to make new investments that will best achieve our vision and mission.

Question. Is NASA going to be unable to continue the commitment to current activities in order to meet the new goals?

Answer. No. NASA will continue to invest in current activities, including priorities in Aeronautics and Earth Science. We will achieve the goals of the exploration vision with increased funding at the Agency level ($1 billion over 5 years above what was planned in the fiscal year 2004 budget request), as well as through a realignment of many ongoing activities that do not support the vision.

FAILED FINANCIAL STATEMENT

Question. NASA has finally achieved an integrated financial management system, yet NASA did not receive a clean audit on its financial statement. Instead, the auditors deemed the books have a reportable condition when faced with being handed records from two different financial systems for last year.

What is the status of addressing this situation and when will we be able to see progress towards correcting it?

Answer. For fiscal year 2004, NASA is operating an Agency-wide, single integrated core financial management system. However, throughout most of fiscal year 2003, NASA was implementing, in 4 separate phases, the new system that replaced 10 disparate accounting systems in operation at our Centers for the past two decades. This conversion effort created some complex accounting issues for fiscal year 2003, which significantly impacted the timeliness and quality of the information required in preparing NASA's interim and year-end financial statements.

NASA had anticipated that fiscal year 2003, being a conversion year to this new Agency-wide accounting system, was going to be an especially challenging time for its external financial reporting activities. Eight of 10 Centers went through this conversion process during the fiscal year 2003 and, accordingly, required NASA to use "blended" data from each Center's legacy accounting system and the new core financial system to ultimately prepare our consolidated fiscal year 2003 financial statements.

NASA expects improvements this fiscal year. There are no more NASA Center legacy systems in operation, and all financial data will be emanating from the one single Agency-wide core financial system. That said, there are numerous challenges ahead both in addressing the issues raised in the fiscal year 2003 audit as well as improving the IFM system based on GAO and internal working group recommendations.

EDUCATION PROGRAMS

Question. It is my understanding that the NASA website has had nearly 8 million hits since the landing of Spirit. Ed Weiler stated yesterday that 20 percent of those hits are coming from children and young adults in the K–12 range.

What is being done to make sure K–12, and even college age students, take this interest and keep the excitement going to become the next engineers and scientists that NASA and the country will continue to have a demand for in the future?

Answer. *Background.*—NASA is confronted with the convergence of three trends that put future U.S. advancements in science, aeronautics, and space technology at risk: (1) reduction in the number of science and engineering graduates; (2) increased competition from the private sector and academia for technical expertise; and, (3) retirement of approximately 25 percent of the current science and engineering workforce within 5 years.

—NASA is implementing a 5-year Corporate Recruitment Initiative, a collaborative effort among the offices of Education, Equal Opportunity Programs, and Human Resources, to focus on the recruitment of, and outreach to, young people from diverse backgrounds who are skilled in high-demand competencies required by NASA, including those necessary for implementation of the long-term Vision for Space Exploration.

—All Education Enterprise initiatives and programs are consistent with NASA's Agency-wide approach to human capital management, and are instrumental in attracting and maintaining a workforce representative of the Nation's diversity to enhance NASA's current and future competencies.

—NASA's commitment to workforce development and future human capital needs is demonstrated by four Pathfinder initiatives:

Educator Astronaut Program.—Provides opportunities for outstanding teachers to become permanent members of the Astronaut Corps. Using the educational expertise of Educator Astronauts and innovative technology of our Edspace website, Earth Crew members from K–12 will be inspired to greater Science, Technology, Education, and Mathematics (STEM) achievement and will be encouraged to pursue STEM careers. An intended outcome of this program is raising the esteem of teachers in the eyes of the public. (Fiscal year 2005 budget request: $2.1 million)

NASA Explorer School (NES) Program.—Establishes a 3-year partnership between NASA and school teams serving grades 4–9, consisting of teachers and education administrators from diverse communities across the country. Focusing on underserved populations, NES engages educators, students, and families in sustained involvement with NASA's research, discoveries, and missions to

promote science, mathematics, and technology learning and career explorations. (Fiscal year 2005 budget request: $13.7 million)

NASA Explorer Institutes Program.—Broadens NASA's reach to students, their families, and the general public for STEM learning outside of formal classroom environments through media, exhibits, and community-based programming. Provides instructional materials and resources for use by the informal education community (including science centers, museums, planetariums, libraries, parks, aquaria, nature centers, botanical gardens, and community-based organizations) and professional development opportunities for informal education professionals. (Fiscal year 2005 budget request: $2.1 million)

Science and Technology Scholarship Program.—Provides college tuition to highly qualified students who, in return, will commit to work at NASA. Established by the NASA Flexibility Act of 2004 (Public Law 108–201). (Fiscal year 2005 budget request: $9.5 million)

—While the Pathfinder Initiatives are directly related to workforce recruitment and the new Vision for Space Exploration, all Education programs support the strategic objectives of increasing the number of students pursuing science, technology, engineering, and mathematics (STEM) disciplines.

BUDGET (FISCAL YEAR 2004–2009)

[In millions of dollars]

Budget Authority	Fiscal Year 2004 [1]	Fiscal Year 2005	Fiscal Year 2006	Fiscal Year 2007	Fiscal Year 2008	Fiscal Year 2009
Education Programs	230.4	168.5	169.4	170.6	169.6	170.3
Education	138.6	77.7	77.9	78.8	78.3	78.4
Base Program	77.7	77.7	77.9	78.8	78.3	78.4
Congressionally Directed	60.9	.....	.....	.....	.....	.....
Minority University	91.8	90.8	91.5	91.8	91.3	91.9
Base Program	90.8	90.8	91.5	91.8	91.3	91.9
Congressionally Directed	1.0	.....	.....	.....	.....	.....

[1] Represents budget as presented in NASA's Initial Fiscal Year 2004 Operating Plan.

Additional Background.—Pathfinder Initiatives highlights for fiscal year 2005 budget:

—*Educator Astronaut Program*.—Earth Crew allows the development of ongoing relationships between NASA and adult-led groups of students (educator/class, parent/family, etc.) for the purpose of exposing students to unique NASA content, careers related to NASA, and the people and mission of NASA. As of March 25, 2004, the total Earth Crew Membership was 92,487. Membership will likely continue to increase, especially after the formal announcement of the newly selected 2004 Educator Astronauts, scheduled for May 6, 2004.

—*NASA Explorer School Program*.—School needs that will be addressed by this program include communication, professional development, partnerships, web-based education resources, and curriculum integration tools. Fifty 2004 NASA Explorer Schools were selected recently. In fiscal year 2005, an additional 50 schools will be added, bringing the total number of partner schools to 150.

—*NASA Explorer Institutes Program*.—Focus group conferences will be held to identify the needs of the informal education community. Plans for a national program of Explorer Institutes for all ten-field Centers will be completed, with 4 institutes being operational in fiscal year 2005.

—*Science and Technology Scholarship Program*.—The first cohort of undergraduate students, jointly selected by Agency personnel and university faculty, and chosen for service in NASA, will be selected.

COST OF THE MOON/MARS VISION

Question. According to your documents, current budget projections assume it would cost $64 billion to return humans to the Moon by 2020, not including the cost of robotic missions. The $64 billion consists of $24 billion to build and operate the Crew Exploration Vehicle from fiscal year 2004–2020, plus $40 billion for fiscal year 2011–2020 to build and operate the lunar lander. This is a significant investment and only captures the lunar portion of the vision. There is also the build up of additional missions to Mars.

My question is, how much is the current estimate for implementing all aspects of the Moon/Mars vision in fiscal year 2005, and from 2005 through 2020?

Answer. The President's fiscal year 2005 budget request includes funding for all aspects of the vision during this time period, including exploration of the Moon, Mars, outer moons and beyond including the search for extrasolar planets that might harbor life. NASA is still developing architectures for human and robotic exploration of the Moon and Mars. Estimates that were used in the budget represent a bounding estimate based on experience and actual costs from relevant elements of the Apollo program. The estimates do not reflect architecture studies, design analysis, new technologies, and innovative approaches yet to be undertaken. They also do not reflect that the exploration vision, unlike Apollo, views the lunar landing not as an end in itself, but as one step in a sustained human and robotic program to explore the solar system and beyond. The lunar exploration will reduce the risks and prepare for Mars exploration, and many of capabilities developed for lunar exploration may be used for Mars exploration as well.

Question. To what extent can robotic spacecraft accomplish these exploration goals instead of humans, at less cost and risk to human life?

Answer. NASA has undertaken a recent analysis of the benefits and cost associated with human space flight, and this response reflects some of the findings of that analysis. Neither robotics nor humans alone could accomplish these exploration goals. Robots cannot discover—they are simply a smart set of sensors and effectors that act as surrogates for and inform human presence elsewhere. Humans cannot explore alone either—the space environment does not allow humans to operate without robotic support—this is often true today on Earth as well. In practice, humans and robots act symbiotically to complete tasks.

Human presence for in situ exploration is both high value and high cost. Humans missions will occur after extensive characterization of the environment and areas of high interest are identified with the assistance of robots. Human presence will lead to huge increases in the speed and quality of the measurements taken, and creates unparalleled ability to observe and make discoveries through the unique capabilities of the human brain. The result is dramatic increases in the pace of discovery and reliability of scientific returns. This comparative advantage was aptly demonstrated by Apollo where human presence quickened the pace of discovery by producing a large quantify of high quality material for analysis that led to dramatic discoveries about the Moon.

Finally, as the President stated on January 14, "human beings are heading into the cosmos." One of the four primary objectives of the new space exploration vision is "to extend human presence across the solar system." This endeavor, intended to improve our lives and lift our national spirit, cannot be accomplished using only robots.

INTERNATIONAL PARTNERS IN THE MOON/MARS VISION

Question. In the President's policy directive, it states that NASA will "pursue opportunities for international participation to support U.S. space exploration goals." We currently have an international partnership with the space station, and our own participation is taking a dramatic change, even before the construction is even completed.

Will other countries be willing to participate if the United States does not live up to its obligations to the space station program, and if the United States insists on directing how the Moon/Mars program is to be conducted?

Answer. The President directed NASA to fulfill our commitments to our partners on the ISS, and we plan to do so. Initial interest by other countries in the vision has been positive, and we expect there will be many opportunities for international cooperation over the course of implementation.

SPACE STATION CREW/CARGO

Question. In your proposed budget, there is $140 million proposed for space station crew and cargo services. This funding will be for launch, delivery, and return services for cargo, and the purchase of human-rated launch and return capabilities.

Why is this money needed at this time, when the anticipated need for such services will not be until 2010? Is this an indication that this will be a recurring cost for the next 5 years?

Answer. NASA will retire the Space Shuttle after completing assembly of the International Space Station, planned for the end of this decade. Even prior to retiring the Shuttle, there is a need for additional cargo capability in order to achieve fuller utilization of the Space Station for conducting research. Offloading some ISS cargo transfer tasks onto commercial services may be key to completing the ISS by the end of the decade, an important step in enabling the New Vision for Exploration. Hence, funding to begin to acquire cargo and crew services is requested in

fiscal year 2005. NASA is beginning to discuss options for meeting cargo/crew delivery and return requirements in both the near term and post-Shuttle. As early as fiscal year 2006, NASA anticipates a need to augment Shuttle and partner-provided services to improve utilization by purchasing cargo/crew services commercially using a full and open competitive acquisition process. Currently, no commercial capability exists that could meet the requirements but there appears to be commercial interest. NASA has no plans to fund the development of this capability and plans to acquire services. However, technology risk reduction demonstrations are under consideration to reduce the risk of development for any potential service provider. The phased funding plan for ISS Cargo/Crew Services is shown in the following table.

Fiscal Year 2005 Request	Fiscal Year 2005	Fiscal Year 2006	Fiscal Year 2007	Fiscal Year 2008	Fiscal Year 2009
ISS Cargo/Crew Services	$140,000,000	$160,000,000	$160,000,000	$160,000,000	$500,000,000

Question. Whom do you expect to provide these services? As you well know, it is currently against the law for us to provide funding to the Russians for vehicles that are doing this type of work for us now.

Answer. NASA is refining projected requirements for ISS cargo and crew delivery and return consistent with the Vision for Space Exploration and existing law and policy. NASA is developing an integrated ISS strategy that considers the full range of domestic and international partner transportation options. These options include: U.S. commercial capability; ISS International Partner assets, such as the European Automated Transfer Vehicle, Japanese Transfer Vehicle, and the Russian Progress and Soyuz spacecraft; and, Transition to capability presently under definition from the NASA Constellation Program, when available, after the retirement of the Space Shuttle in 2010.

NASA recognizes there are unique challenges associated with each of these space access options and is committed to assuring safe, reliable and affordable access and operation to the International Space Station.

ARBITRARY DATE OF 2010 FOR SHUTTLE RETIREMENT

Question. During the hearing, it was contended that the 2010 recertification date mentioned in the CAIB report might have been an arbitrary date picked by the CAIB.

If NASA is going to comply with the CAIB report 100 percent, as has been stated numerous times before this subcommittee, how can a specific date within the report for recertification be determined to be arbitrary?

Answer. The Space Shuttle Orbiters were designed with an operational life of 100 flights. Given that no Orbiter in the current fleet has been flown more than 30 missions, the Shuttle is potentially capable of flying until 2020 or beyond. Mid-life certification was projected for approximately 2010. This target date became the logical point for completing recertification. Since the Space Shuttle fleet will now retire after completion of assembly of the International Space Station (ISS), currently planned for the end of the decade, NASA is appropriately readdressing recertification norms.

The CAIB report was written when the Space Shuttle was expected to play a major role in ISS logistics, science and crew exchange following full assembly. Given that the Vision for Space Exploration calls for an end to the Space Shuttle program at the completion of ISS assembly, planned for the end of this decade, the purpose and need for recertification is less clear. The Shuttle Service Life Extension Program (SLEP) has been tasked to address this CAIB report recommendation, and reviews are currently in progress.

Question. What documentation can you provide that indicates that such a date was, in fact, arbitrarily made?

Answer. Given that the 2010 date for recertification reflects the projected mid-life certification date, the Orbiters' design certification documentation support the CAIB's decision. However, since the subsequent Vision for Space Exploration calls for the Space Shuttle to retire in this timeframe, recertification must be reevaluated.

HEAVY LIFT CAPABILITY BEYOND SHUTTLE

Question. Assuming that the shuttle is retired in 2010, there will be no heavy lift capability available for NASA. The military has chosen to end Titan program with the final launch in early 2005, leaving virtually no options for the necessary cargo transport services that will be needed for the Moon/Mars vision.

What is NASA doing to ensure that reliable heavy lift capability is available to NASA once the shuttle is retired?

Answer. Consistent with the Vision for Space Exploration, NASA seeks to safely return the Space Shuttle to flight, currently planned for March 2005. Over the remainder of the decade, the Space Shuttle will be used to complete assembly of the International Space Station (ISS). NASA utilizes a mixed fleet launch strategy that takes advantage of both domestic and International Partner launch capabilities across a full spectrum of performance ranges.

NASA is developing a Shuttle retirement strategy that will assure space access for required U.S. support to the ISS and future Space Exploration requirements. Ongoing NASA assessments consider use of both domestic Evolved Expendable Launch Vehicle (EELV) capability to meet higher performance requirements as well as International Partner launch capability. The first EELV launch of the Boeing Delta IV-Heavy vehicle configuration, with a similar performance capability as the Space Shuttle and soon-to-retire Titan IV ELV, is planned for this summer.

In parallel with the architecture planning and requirements definition for space exploration, NASA has initiated a number of studies to evaluate future heavy lift demand and potential domestic capabilities beyond that of current systems, which could meet yet-to-be defined requirements. As the architecture planning, requirements definition, and study results mature, NASA will continue to evaluate and plan for all its launch requirements, including heavy lift, in coordination with the Department of Defense to assess requirements in this class from a National perspective.

Question. Will NASA need to develop a new heavy lift capability that is not yet a part of the Moon/Mars plan, and at what cost?

Answer. As stated above, NASA has initiated a number of studies to evaluate future heavy lift demand and potential domestic capabilities beyond that of current systems, which could meet yet-to-be defined requirements. As the architecture planning, requirements definition, and study results mature, NASA will continue to evaluate and plan for all its launch requirements, including heavy lift.

RUSSIAN SOYUZ SAFETY

Question. NASA recently announced a further slip of the shuttle's return to flight until March or April of 2005. NASA should be commended in taking its time to ensure that all the necessary CAIB recommendations are implemented properly. However, in the meantime, we are relying on Soyuz to deliver and return crews to and from the ISS. This begs the question of whether the Soyuz meet the same expectations of safety that we now expect of our own vehicles after the tragic loss of Columbia.

Can you explain what steps NASA has taken to ensure that the Soyuz vehicles meet the basic safety requirements that are embodied in the CAIB recommendations?

Answer. NASA has significant interaction with the Russian Federal Space Agency (FKA) and the vehicle manufacturer (RSC-Energia) regarding safety of the Soyuz vehicles. On the basis of this interaction and the historical record of Soyuz and Soyuz-derived vehicle performance, NASA is confident that the Soyuz is among the safest spacecraft ever flown.

The continued use of the expendable Soyuz spacecraft does not present a "new" certification requirement. Each vehicle is operated within the design, certification and experience of our Russian partners. Under the provisions of the Memorandum of Understanding between NASA and Rosaviakosmos (now the Russian FKA) concerning cooperation on the International Space Station (Article 10.2), FKA is responsible for meeting or exceeding the overall Space Station safety and mission assurance requirements and plans established by NASA and the Partnership. ("In support of NASA's overall responsibilities to assure safety and mission assurance, FKA will be responsible for certifying that the Russian Segment and the FKA-provided elements, including cargo, are safe and ready for operation using jointly agreed documentation and processes.") The Soyuz has been certified under these conditions. Under the provisions of the MOU, NASA is not responsible for certifying Russian vehicles for flight and FKA is not responsible for certifying NASA vehicles for flight.

In addition, each Soyuz mission undergoes a number of joint Russian and U.S. expert reviews. Prior to each mission, the U.S.-Russian Stafford-Anfimov Joint Commission conducts an in-depth joint assessment of the operational readiness of the mission. The resulting report is one of the inputs to the detailed NASA technical reviews that culminate in a Flight Readiness Review for each mission.

The certification under the MOU, our technical and safety history with Soyuz vehicles, and current processes for joint Station operations combine to ensure the safety of future use of Soyuz.

QUESTIONS SUBMITTED BY SENATOR CONRAD BURNS

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCOR)

Question. The NASA Experimental Program to Stimulate Competitive Research (EPSCoR) program was authorized in 1993 to help develop academic research in space science, aerospace technology and aerospace-related research in 19 States and Puerto Rico that have historically been less successful in obtaining NASA research funding. NASA EPSCoR has been extremely successful in my State of Montana. Montana and the other EPSCoR States are currently in the fourth year of 5-year research grants from NASA. Since fiscal year 1999, some $10 million has been available for this program annually. However, the fiscal year 2005 budget request is $4.6 million. Without additional funding, Montana will not be able to complete its 5-year research program. Can you help us find the funding for EPSCoR, which has been so helpful to Montana?

Answer. Awards under the current NASA EPSCoR program were granted in 2001 for a 3-year period with an option for a 2-year extension based on a competitive review of progress made. Review of those continuation requests will be conducted later this year. The most competitive programs that demonstrate successful progress will be granted continuation awards in accordance with the available budget.

Question. Since fiscal year 1999, Congress had funded the NASA EPSCoR program at $10 million annually but each year the budget request seems to revert to $4.6 million. This is an on-going, authorized program with important results in the participating States. Why do we see this constant push back?

Answer. NASA has requested funding for the program in the President's budget request every fiscal year since the NASA EPSCoR legislation was authorized and considers the program a vital part of the Agency's education portfolio. The NASA budget request for EPSCoR is at a level that reflects the importance of the EPSCoR program balanced against other program priorities.

NASA is committed to the EPSCoR program. The program is a strong component of the Office of Education workforce development and research capacity building strategy. The NASA EPSCoR Program provides seed funding that enables eligible States to develop an academic research enterprise directed toward long-term, self-sustaining, nationally competitive capabilities in space and Earth science and applications, aeronautical research and technology, and space research and technology programs. This capability contributes not only to the State's economic viability but to the Nation as a whole.

PRIVATE CORPORATIONS

Question. As I mentioned previously, it is critical for NASA to attract private sector dollars to the space field. I know that private corporations working in conjunction with the Inland Northwest Space Alliance in Missoula, Montana, have made a huge financial investment in expandable space structures, a technology that NASA did some work on under the auspices of the Transhab project. What is NASA doing to leverage these corporations funding of this new technology and to encourage other entrepreneurs to make similar investments?

Answer. Two fundamental goals of the Vision for Space Exploration are to: develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration; and promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.

To achieve these goals, NASA is undertaking two new approaches to systems and technology development: Broad Agency Announcements (BAAs), and a competitive prize program called Centennial Challenges. In addition, NASA's existing Innovative Technology Transfer Partnerships and Enterprise Engine programs will work to build relationships with private industry and NASA will ensure that open, competitive processes are used throughout our Human and Robotic Technology (HRT) development programs.

To solicit private sector inputs on how to best frame future systems development and procurement decisions, NASA's Office of Exploration Systems is employing Broad Agency Announcements (BAAs). BAAs have been previously used by the Department of Defense to obtain a wide range of company, government lab, and university views on what systems, technologies, and expertise are needed to achieve a

particular operational capability. This will be the first time that NASA has employed BAAs, and it should allow companies, both large and small, the opportunity to put forth innovative ideas that could have a profound impact on how NASA and the Nation implement future exploration activities, such as Project Constellation (the Crew Exploration Vehicle).

To ensure that NASA reaches the broadest segment of innovators possible, NASA's Office of Exploration Systems has also started a new program of prize competitions called Centennial Challenges. Instead of soliciting proposals for a grant or contract award, NASA will set a challenge, the prize amount to be awarded for achieving that challenge, and a set of rules by which teams will compete for that prize. By specifying technical goals but not pre-selecting the best way to achieve them, NASA intends to stimulate innovation in ways that standard Federal procurements cannot. Centennial Challenge winners will be judged and earn awards based on actual achievements, not proposals. Using this approach, NASA's research will be enriched by new innovators that do not normally work on NASA issues. Through Centennial Challenges, NASA intends to reach new innovators and find novel or low-cost solutions to NASA engineering problems that would not be developed otherwise.

NASA's Office of Exploration Systems has inherited NASA's ongoing Innovative Technology Transfer Partnerships (ITTP) program. In recent years, the focus of the ITTP programs has been rebalanced to include both "spin-off" (transferring NASA-developed technologies to the private sector) as well as "spin-in" (leveraging private sector technologies for NASA missions). Through ITTP, NASA also plans to undertake novel new joint research and development projects with the private sector.

In addition to the programs within the Office of Exploration Systems, the Office of Biological and Physical Research Space Product Development division (SPD) manages the Research Partnership Center (RPC) program. This program brings industry, academia and government together to create new technology having application to both NASA and the private sector. In this way the RPCs are creating benefits to the public through their research directed toward NASA's needs. These centers are engaged in a wide range of areas of applied research, including advanced materials, agribusiness, biotechnology, communications, imaging, medical informatics, telemedicine, spacecraft technology and space resource utilization.

Finally, NASA's Office of Exploration Systems will be making significant investments in new technologies to support the development of future exploration systems through the Human and Robotic Technology (HRT) Program. The Office of Exploration Systems is committed to ensuring that HRT programs use open and competitive processes for selecting and awarding grants and contracts. This will help ensure a level playing field between private sector and public sector R&D organizations seeking HRT awards.

INTERNATIONAL SPACE STATION

Question. After the International Space Station is "phased out" in 2016, what do you plan to do with the facility? Could the private sector potentially have a role in managing the Station?

Answer. In the broad context of the Vision for Space Exploration, the ISS will be utilized through at least 2016. It will serve as a significant test bed for the research and technical development needed to fulfill the objectives of the Vision. It is premature to comment on any determination regarding what will happen to the ISS beyond 2016. While there are no specific plans for private management of the Station, such a proposal would have to be thoroughly evaluated at the appropriate time in the future. Future management of the ISS will need to be fully coordinated with our International Partners in accordance with our ISS agreements.

There is a plan for the safe and orderly de-orbit of the Station when it has reached the end of its service life.

CREW EXPLORATION VEHICLE (CEV)

Question. Currently, the only avenue for the private sector to purchase a crewed spaceflight opportunity is aboard the Russian Soyuz. Is NASA anticipating the development of a version of its Crew Exploration Vehicle that could some day carry non-NASA personnel?

Answer. The CEV is expected to be dedicated to executing the new Vision for Space Exploration. It is doubtful that NASA would itself develop a version of the CEV to carry paying customers, since entering the commercial market is not an appropriate role for government. However, NASA will consider following the model from its aeronautical history, whereby the technologies developed for the CEV could

be made available to commercial interests that could then develop a vehicle to meet market driven requirements.

QUESTIONS SUBMITTED BY SENATOR LARRY CRAIG

SPACE NUCLEAR

Question. I am excited that the space nuclear mission for the production of the "RTG"—the plutonium generators that power many space probes—has now been successfully transferred to Idaho—and production of these nuclear generators is now taking place at Argonne West.

I think this work is a success. I understand that the Department of Energy and NASA are both happy with this work in Idaho. I hope to build on this mission.

I notice that the budget request includes $438 million for Project Prometheus and for furthering NASA's efforts in advanced nuclear propulsion systems—to move beyond the RTG to actual nuclear fission reactors in space.

With your Navy background, you know that the Naval Nuclear Propulsion program safely travels throughout the oceans and all around the globe—powered by nuclear reactors. This program provides a good analogy for the potential of nuclear in space—the ability to travel great distances and a long time between re-fueling. In fact, Navy reactor cores now last the "life of the ship".

One of the reasons this is possible is because Naval Reactors has a large operation in Idaho—located on the Idaho National Engineering and Environmental Laboratory. Every element of Navy fuel, discharged from its ships, is sent to Idaho for destructive examination and testing. The Navy has developed all its fuel, based on testing done in Idaho's Advanced Test Reactor.

DOE seeks to establish a nuclear energy center of excellence for civilian nuclear power in Idaho. I think NASA's space nuclear efforts and those of the Navy fit well into this center.

Given the importance of advanced nuclear propulsion to achieving the new vision for U.S. space exploration laid out by the President, could I have your commitment to come to Idaho—to see the capabilities of the Idaho lab and to see the Naval Reactors work there?

Answer. NASA has been in touch with your staff regarding this matter.

ADVANCED MICROELECTRONICS

Question. In fiscal year 2004, Congress provided $1 million of additional funding for advanced work in radiation hardened, ultra low power micro-electronics work associated with a research center in Post Falls, Idaho. This additional funding was intended as an increase to some ongoing work that NASA Goddard was doing in Idaho—not as a substitute for that work—which had already been competitively awarded. In other words, these items were not meant to cancel each other out. I understand that NASA is still engaged of a review of Congressional earmarks and will finish that review by the end of the month.

Could you please look into the status of release of this funding, and have your staff report back to my office?

Answer. NASA has been in touch with your staff regarding this matter.

QUESTION SUBMITTED BY SENATOR HARRY REID

JOINT DARK ENERGY MISSION (JDEM)

Question. I was recently pleased to learn that NASA and the Department of Energy are collaborating on the Joint Dark Energy Mission (JDEM) in an attempt to answer the most fundamental science questions of the day—of what is the universe made and why is the universe expanding at an ever increasing rate. Unfortunately, although the Department of Energy requested around $7.6 million in its budget request for JDEM, it appears that NASA failed to meet its commitment to this program and did not include funding in its fiscal year 2005 budget submittal. What does this lack of resources mean for the program and for the collaboration that NASA entered into with DOE? There is wide agreement within the scientific community that this program is critical and in need of immediate funding to ensure that it remains robust and productive—could you please explain why NASA chose not to include JDEM in its budget request? Please keep the committee abreast of the Department's actions and intentions regarding JDEM.

Answer. NASA has not abandoned its desire to participate in the NASA-DOE mission called JDEM. NASA and DOE have agreed on an outline of the joint mission.

The principle investigator-led science investigation will be competitively selected jointly by NASA and DOE. The science investigation and mission operations will be jointly funded. NASA will take responsibility for the project, prime contractor, launch, general observer program, and data archive.

DOE is funding research that is applicable to JDEM. NASA is funding mission concept studies by potential proposers ($500K/yr in fiscal year 2004 and fiscal year 2005). NASA Centers are spending advanced project funds on studies as well ($800K to $1M in fiscal year 2004). NASA is evaluating five mission concepts (from Lawrence Berkeley Laboratory; JPL; GSFC; Arizona State University; and Conceptual Analytics, LLC) looking at a variety of architectures, instruments, and technologies.

NASA finds the JDEM mission scientifically compelling; however, as an agency, we must always prioritize among competing research programs. Whenever possible, we enlist the aid of our advisory committees and the guidance of the National Research Council (as outlined the most recent Decadal Survey). This approach ensures that the opinions of the scientific community remain important considerations in NASA decisions.

While it is true that NASA will not begin full JDEM development this year, important precursor activities are being undertaken to ensure that we will be prepared to begin, should the decision be made to proceed with JDEM.

SUBCOMMITTEE RECESS

Senator BOND. Thank you very much, Mr. Administrator.

Mr. O'KEEFE. Thank you, sir.

Senator BOND. The meeting is recessed.

[Whereupon at 11:42 a.m., Thursday, March 11, the subcommittee was recessed, to reconvene subject to the call of the Chair.]