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NASA'S SPACE SHUTTLE PROGRAM

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED EIGHTH CONGRESS

SECOND SESSION

SEPTEMBER 8, 2004

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ONE HUNDRED EIGHTH CONGRESS

SECOND SESSION

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NASA'S SPACE SHUTTLE PROGRAM

WEDNESDAY, SEPTEMBER 8, 2004

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 10:07 a.m. in room SR–253, Russell Senate Office Building, Hon. Sam Brownback, presiding.

OPENING STATEMENT OF HON. SAM BROWNBACK, U.S. SENATOR FROM KANSAS

Senator BROWNBACK. Good morning. I call the hearing to order.

I want to thank the Commerce, Science, and Transportation Committee Chairman for holding this hearing on NASA's Space Shuttle Program. Chairman McCain will be in, I think, in about a half an hour or 45 minutes to chair the hearing. Until that time, I'll be chairing it.

Before I begin, I understand that the recent hurricanes in Florida did significant damage to our space facilities there. I saw an article in this morning's paper, and I want you to know that I share the concerns for NASA's people and programs in Florida, and I offer my full support in our efforts to recover from the damage, Mr. Administrator, on that, and to all Floridians. I think we all watched that storm come in, the storm the size of Texas over Florida, and were just amazed at the power and the destructive capacity, and we'll want to hear about what that has as its impact. But our first and foremost concern is for the people, and we hope and pray that they're safe and sound and will be able to recover, as well as for all Floridians. And we'll hear from Senator Nelson here in a minute who can give us more personalized details of what's been taking place.

The Space Shuttle is a magnificent machine, and it's clear that the dedicated and talented people at NASA are doing their best to return it to flight. I am concerned, though, to be sure, about the schedule and the cost of this return, and that's what I want to particularly focus on in this hearing this morning. I'm confident that, with enough money and time, we will succeed, but the more we spend on this legacy system, the more we mortgage our future.

I believe in the Administration's space exploration program. I believe space offers enormous opportunity for our people. I'm concerned that our economic and military competitors around the world are breathing down our neck in space. This is one competition we can't afford to lose. Every dollar spent on space exploration must be spent extremely wisely.

As the Space Shuttle Return to Flight costs mount and schedules become less certain, the time has come to find alternatives, I believe, to the Shuttle. As I've said before, we are never going to realize the benefits of space without full mobilization of all the assets that we have available to us as a country, including the private sector. A number of private concerns, including some of the Nation's largest aerospace firms, have told me they have affordable, near-term options to offload some, and perhaps all, of the Space Shuttle's launch requirements.

In previous testimony, NASA said it hasn't considered alternatives to the Space Shuttle for completing and maintaining the Space Station. Yet recent external studies, such as one done by the Planetary Society, suggests that as few as 10 to 12 Shuttle flights, and not 30, as the plan now stands, could suffice to complete the Space Station if alternative means of access are also used.

For these reasons, I've asked, in concert with my House colleagues, for a GAO analysis of these issues. I helped commission the Congressional Budget Office to study the issue of space exploration costs. They tell me that the President's Space Exploration Program is affordable within the money we've budgeted, provided we come to grips with an affordable launch system. Meanwhile, every day we focus our resources to maintain the current Shuttle infrastructure is a day we delay our people's exploration and expansion into the solar system.

This is an important issue. I look forward to hearing NASA's information today about the program, because we do want to see what it is it's costing us and what the time-frame is going to be on Return to Flight on the Space Shuttle, and is there a way for us to be able to go to fewer flights and then move those resources into Moon, Mars, and beyond in the manned space program.

Senator BROWNBACK. I want to turn the program over to the—podium over to Senator Bill Nelson. And, again, our condolences to all of Florida and all Floridians for Hurricane Frances and, as I understand, maybe another one coming through.

Senator Nelson?

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

Senator NELSON. Thank you, Mr. Chairman.

Mr. Chairman, if I'm a little blunt, you will please understand that I have been dealing with hurricanes for the last four and a half weeks, and, as reflective of Floridians, our patience is wearing thin. Even though there has been a magnificent response and lessons learned from Hurricane Andrew, where one level of government was not talking to the other level of government, those lessons were learned, and the response has been very good, but some of the damage that was done is illustrative of mistakes that have been made.

And I specifically want to take this opportunity, while we have the Administrator here, with regard to the damage at the Kennedy Space Center. As, no doubt, you will share with this Committee, at least a thousand panels were lost from the Vehicle Assembly Building (VAB). These are large panels, panels usually 10x4 feet, in one other section, a major section was lost. Why? It's simply because

NASA has been robbing Peter to pay Paul, because NASA has not had the increases that it has needed to do an ambitious space program, and you can't do spaceflight on the cheap. And so NASA, in order to try to do everything it wants to do, takes away from where? Maintenance of facilities. And in the corrosive salt air of an ocean launch site, you're going to have degradation of facilities. And I think we're beginning to see that. And the VAB is an example.

And fortunately, no hardware, per the briefing that I had from Jim Kennedy, who is the director of the Kennedy Space Center—no hardware was harmed, but you've basically got a thousand panels off, which means you've got a thousand windows open if this next hurricane were to come. And what kind of damage would that do to the VAB and our ability to stack the spacecraft vertically, which is where that's done—in the VAB? But there were more problems.

Now, fortunately, in the three Orbiter Processing Facilities, there was no damage. But the fact is that power went out. And in *Discovery* that's being prepared in OPF number three, power went out. Why? Why was there not the generator capacity there that would kick in when the power went out? And although it does not appear that there was any damage to the spacecraft or *Discovery's* preparation, is this, again, another example of robbing Peter to pay Paul over the last decade that does not give us the maintenance?

Now, what we're talking about is nothing new. We've been talking about this for years. But it's an allocation of resources, and I think it's finally coming home that Florida is a place that is threatened by windstorms, and we'd better get it right.

And then there was the question of the building that housed major computers as a computer center, that did sustain significant damage on the roof. And, again, why is a computer nerve center housed in a building that is not constructed to withstand hurricane-force winds?

Now, eerily, the track of Ivan is forecasted to come right over Western Cuba. Does that sound similar to a hurricane three and a half weeks ago named Charley? And if it takes a jog to the right, like Charley did, in Southwest Florida, coming right across the State of Florida—and Lord help us that this does not occur—but it would be headed straight for the Kennedy Space Center.

In the last one, the winds—Charley—only brushed the north end of the Space Center, since it exited at Daytona Beach. But, even so, KSC suffered $750,000 worth of damage. So in this $2 billion that we passed last night that's just for FEMA, that's nothing for NASA. And in the $2.5 billion dollars additional that I have requested of the President to request for Department of Agriculture and FEMA and Department of Defense and Department of Commerce, is any of that going to go to NASA? I think we'd better make our requests known and get serious about our budget for NASA in the future. The space program is too important to every American that it be successful, and we've got to stop robbing Peter to pay Paul.

Thank you, Mr. Chairman.

Senator BROWNBACK. Thank you. As I said at the outset, our thoughts and prayers go out for the Floridians.

We have two people on the panel, the Honorable Sean O'Keefe, Administrator of NASA, and Lieutenant General Thomas P. Stafford, U.S. Air Force (Retired), Co-Chairman of the Return to Flight Task Force. Gentlemen, we look forward to both your testimony.

Administrator O'Keefe, let's take your comments and your testimony first. Thank you for joining us.

STATEMENT OF HON. SEAN O'KEEFE, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. O'KEEFE. Well, thank you, Mr. Chairman. And Senator Nelson, Senator Lott, pleasure to see you, as well.

And I've got a statement for the record I'll submit and just briefly summarize it——

Senator BROWNBACK. And it'll be put in the record.

Mr. O'KEEFE. Appreciate the opportunity to appear before the Committee, along with General Tom Stafford, to discuss our efforts to return the Shuttle to flight and raise the bar on all of our mission operations.

Right after the *Columbia* accident, I certainly had the opportunity, in a joint session of this Committee and the House Science Committee, to pledge that we would find the cause of the *Columbia* accident, correct the problems we find, and return the Shuttles to flight. And we're doing just that.

I'm pleased to report today about the tangible progress we're making toward achieving those milestone-driven Return to Flight goals, and we are accomplishing those as we move along here.

It is—all the members of the NASA family, I think, have been constantly diligent, which is the minimum price of admission for conducting research and exploration on behalf of the American public. Throughout NASA, we have had many examples of diligence and deliberate action we've taken to improve the conditions of all three Shuttle orbiters and to minimize the risk associated with flight.

We've conditionally closed five of the 15 recommendations of the *Columbia* Accident Investigation Board; and the Return to Flight Task Group, co-chaired by General Stafford, and his Co-Chair, as well, Dick Covey, who was the pilot on the Return to Flight effort after *Challenger*, have concurred in those five of 15 recommendations at this point.

The Stafford-Covey Task Group are all external experts, they are dedicated professionals, and we are incredibly grateful to them for all the time and effort they've put into assuring that we remain diligent in this particular task. They, probably more than any other collection of folks, are looking forward to Return to Flight so they can return to their day jobs on a regular basis, but they are dedicating a tremendous amount of time right now to assure that we have looked at every option and that we're selecting the best options as we move forward in order to meet the recommendations of the *Columbia* Accident Investigation Board.

We're making progress on the remaining ten Return to Flight recommendations, and hope to close them out by year's end. But, again, we'll look at how we track on that and what the response is from the Stafford-Covey Task Group.

Throughout the agency, we're striving to transform the culture and the organization so that all employees are empowered to speak up on issues impacting mission safety, as well as our approach to how we return to flight. In an agency-wide initiative, the outstanding engineers serving in our 1-year-old NASA Engineering and Safety Center, located at the Langley Research Center, are also providing us many good approaches to improving decision-making and risk-management process and looking at the trend analysis that, I think, was so carefully articulated by the Accident Investigation Board, as well.

We're vetting options now to establish the independent technical authority to oversee the technical standards and requirements. And the board recommended that we develop a plan. Our intent is to develop that plan and implement it before Return to Flight. And, again, our colleagues on the Stafford-Covey Task Group are being very diligent about assuring we pick the very best option to proceed with that. But we're really being more ambitious than even what the Board had recommended at that time in order to assure that we get this right.

We've begun restructuring our engineering functions, with a focus on providing rigorous independent oversight of the technical work performed by all of our programs. And specifically for the Shuttle program, we've expanded the responsibility and the authority of the Space Shuttle Systems Engineering and Integration Office to improve the internal communications and coordination of all the technical issues resolved.

The Space Shuttle program has added the NASA Engineering and Safety Center and plans to add the independent technical authority to formal boards and the Shuttle Mission Management Team to assure broader independent evaluation of critical decisions as they're rendered. These are just a few examples of the numerous changes that are ongoing throughout the Shuttle program, and the agency overall, to strengthen the culture, improve how we're organized, to enhance our ability to perform the mission while focusing on the imperative that we do it as safely as we can.

Throughout this process, we've regularly informed Congress about the Return to Flight activities. There have been six revisions to the implementation plan that we first initiated back after the *Columbia* Accident Investigation Board report was issued on the 26th of August of last year. And since that time, each iteration and update we've released includes not only the updated analysis, but also an estimated Return to Flight cost.

The current cost estimates provided to the Committee in late July take into account all currently known potential costs and, certainly at this particular juncture, that's what our best estimate is of what it's going to take to move ahead. The prepared statement goes through that in detail. And, Mr. Chairman, as you've alluded, we'll get into that, I think, in much greater detail in our discussion here.

It's possible that this estimate will change. It certainly will as we continue to move forward and address new challenges as they arise after the first two flights. The estimated cost right now of Return to Flight activities for this coming fiscal year is $643 million for

2005. Currently, we're projecting $465 million for the current fiscal year as we close out here in the next 3 weeks ahead.

These estimates reflect factors—let me just quickly move through. As a result of our efforts to meet the recommendations of the *Columbia* Accident Investigation Board we've continued to identify safety-related issues that require additional work, and each of those have been identified in turn. We're undertaking major modification on all three of the Shuttle orbiters simultaneously. Typically, we do that one at a time and heel-toe that process over the course of several years. We're doing all three now. Since they are all down and will remain in a no-fly status until such time as the Accident Investigation Board recommendations are met, we're using that time now in order to assure that we've torn down every one of the orbiters and reconstructed it to the standards we believe are necessary to meet those recommendations.

We're addressing a number of technical requirements up front, resulting in the front-loading of many activities in many instances, yet demonstrating, again, the diligence based on the experience, as well as, again, the constant expert advice we're receiving from the Stafford-Covey Task Group.

Because of the diligence, we're introducing a higher level of engineering and technical rigor in all the safety and engineering processes and practices, and many potential flight risks have been reevaluated and, in some cases, mitigated. We will never eliminate the risk of spaceflight. Never. Our intent here is to try to do much better than what we've seen in the past and to eliminate as many of the known obstacles toward those safety objectives as we can do.

Across the board, our flight hardware is now subject to a greater level of test, tear-down, inspection, repair, and certification for flight, and not all of them are going to be met for those particular cases. We're doing the best we can in order to assure that we've gone through all the major modifications for all three of the orbiters simultaneously to assure the best condition we can. And all the elements—of reassessing the adequacy of industrial processes, safety controls, integrated hazard analyses, and flight hardware test protocols—all those are being met.

Along the way, I think, as Senator Nelson referred to, we've also had to wrestle with the challenges of acts of nature. And, as a consequence, this particular latest example of this with Hurricane Frances has been a really challenging problem. I think, as the Senator referred to, there are a number of cases in which the damage, particularly on the Vehicle Assembly Building, or the VAB, has lost the better part of a thousand panels. And, you're exactly right on the estimates of what's involved there, in terms of how extensive that damage is. That is—been a rather extended effort that will be required in order to replace that in the time ahead, and we're just now in the process of evaluating what will be required there.

We've also lost the Tile Repair Facility and the—for the thermal blankets and so forth that are constructed in those particular shops. The roofs have caved in, in a couple of those cases. And so, as a result, that's going to require some readjustment of that workload either at Houston or back at Palmdale, one or the other. We'll

figure that out here in the very short time ahead. And this is the—what's remaining of the Tile Repair Facility itself.

That said, as bad as the damage was—I think Senator Nelson got it exactly right—all three of the orbiters—*Atlantis*, *Discovery*, and *Endeavor*—went through this particular hurricane unscathed. No water damage. The facilities were battened down all the way through, as well as all the hardware for the International Space Station. That has been preserved, as well. So there are a number of different cases that came out of this about as well as could be expected, given the ferocity of the hurricane-force winds that came through, as well as the water damage that was encountered.

So all things considered, Jim Kennedy and the Kennedy Space Center Team did an absolutely splendid job, in my estimation, of preparing for the worst, anticipating the worst, and riding through what was really a hellacious event that, fortunately, we came through it with all the orbiters preserved.

What this will mean in terms of our current schedule, I don't know. We're still assessing that right now, and it's been no more than 48 hours past the initial assessment, and we'll determine that in very short order. And we're working with our friends within the Administration to determine exactly what the impact of that will be, and what the consequences should be, for the upcoming efforts. That's underway immediately. So we're doing the best we can, given the 48-hour time span that has already elapsed.

Let me just summarize a couple of quick points, as well. We've provided, again, the six different versions of the *Implementation Plan for the Space Shuttle Return to Flight and Beyond.* Each of those are updates of the previous position, just to make sure that everybody is aware of exactly where we are. And the latest one was issued not more than 10 days ago.

The words for the title of the plan, *Implementation Plan for Space Shuttle Return to Flight and Beyond,* were carefully chosen. With the new Vision for Space Exploration announced by the President in January, the Return to Flight of the Space Shuttle and the completion of the International Space Station are the first major steps in order to accomplish that Vision objective. It's a compelling plan for exploration. It will take our pioneers and robotic explorers back to the Moon and on with Mars and beyond, and the value that we will gain by completion of the International Space Station will contribute to that particular effort. It is the first step in what the President directed us to do.

In pursuing the Vision on behalf of the American public, NASA will explore answers to fundamental questions of importance to science and society, develop revolutionary technologies and capabilities for the future, while doing our best to maintain our stewardship along the way. I think the American people are inspired by the current exploration activities, which go to the heart of what the Vision is all about. The President got it right. The *Columbia* Accident Investigation Board called for a spirit of debate. We got one. The President released that on January 14th, and the budget to support that has been submitted to the Congress, and we await the action on the part of the Congress to support it, as well.

This very day, NASA is attempting and helping to carry out that torch of exploration forward through missions taking place in orbit

around Saturn, on the surface of Mars, in Earth's orbit aboard the International Space Station with Expedition 9. And in about 2 hours over the skies of Utah, when we will conduct a daring helicopter capture of the Genesis mission capsule containing the first solar-wind particles to be returned to Earth for study. Hopefully, we will get a report on that before hearing's end.

In summary, we're now focused throughout the agency on the painstaking work that it will take in order to return the Shuttle to flight operations. We're moving forward with a great sense of responsibility and determination. And due to all the steps we've taken, we're optimistic that we're on track for returning the Space Shuttle to flight next spring. The STS–114 mission, which is commanded by Air Force Colonel Eileen Collins, her second command and her fifth flight, will be our next step, following continued construction of the International Space Station. And, of course, we'll fly only when we're absolutely certain we've taken the necessary steps to assure that we've met all the recommendations, again, to our satisfaction, which should be the highest bar that will be established.

And, again, Mr. Chairman and members of the Committee, I thank you for the opportunity to appear this morning.

[The prepared statement of Mr. O'Keefe follows:]

PREPARED STATEMENT OF HON. SEAN O'KEEFE, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Chairman and members of the Committee, thank you for this opportunity to appear today to discuss the status of NASA's Space Shuttle Return to Flight (RTF) effort. When the President visited NASA Headquarters on January 14, 2004, and announced the Vision for Space Exploration, he presented a bold and forward thinking vision that is affordable and achievable. He stated that the first order of business is to safely return the Space Shuttle to flight as soon as practicable, so that we can complete assembly of the International Space Station (ISS), focus Station research on supporting exploration goals, and fulfill the commitments to our International Partners. These are the first steps on the journey to fulfill the Vision for Space Exploration.

As the loss of *Columbia* and her crew reminded us, working in space is inherently risky. The *Columbia* Accident Investigation Board, ably led by Admiral Harold Gehman, recognized the risks associated with operating the Space Shuttle and made its recommendations consistent with an overriding safety objective. NASA recognizes these risks and is working to mitigate them, while moving forward to accomplish our missions.

Today's hearing provides an opportunity to focus on the two key elements in our progress to safely return the Space Shuttle to flight: (1) our cultural and organizational changes, and (2) our technical solutions. The Gehman Report indicated that systemic cultural and organizational shortcomings contributed as much to the *Columbia* accident as any technical failure. NASA brought in outside experts to conduct an in-depth assessment and to identify areas where we can change our culture and organization to improve decision-making, risk management, and communications. Recommended changes have been progressively implemented, and we are pleased with the progress achieved through the efforts of the NASA Team. We understand that addressing these elements, along with fixing the technical issues that led to the *Columbia* accident are critical to improving our standards and performance.

Our decision-making and risk management processes have been enhanced through the establishment of the NASA Engineering and Safety Center (NESC) at Langley Research Center. The NESC's purpose is to provide independent technical expertise for engineering, safety, and mission assurance to augment the capabilities inherent in NASA's programs. In addition, NASA began restructuring its engineering functions with particular focus on providing independent oversight of the technical work performed by the programs and improving technical standards. We are working through options to implement an Independent Technical Authority (ITA) for

approval of waivers to technical standards and requirements. The Board recommendations urged that we develop a plan for ITA—we are seeking to implement the plan before Return to Flight. Within the Space Shuttle Program Office, NASA expanded the responsibility and authority of the Space Shuttle Systems Engineering and Integration Office to improve internal communications and coordination of technical issue resolution. The Space Shuttle program has added the NESC to formal boards and the Mission Management Team to assure a broader, independent evaluation of critical decisions. These are just a few examples of the numerous changes that are ongoing throughout the Space Shuttle program and the agency to strengthen our culture, improve how we are organized, and enhance our ability to perform our mission while focusing on safety first.

When we began developing our RTF plan, we understood the technical solutions to the challenges we faced would evolve over time. There were no predetermined answers coming out of the Board's recommendations, little prior experience to guide us, and no easy fixes. We put our best engineers on the job and our best managers in key positions to ensure that the Shuttle would be as safe as reasonably possible when it flew again. We have pursued multiple paths for some of the solutions in order to maintain our forward momentum. We have rescheduled the launch window several times to reflect achievement of milestones rather than have the schedule drive our planning. We have not allowed the budget to dictate the answer to any of the *safety* issues we faced. We have gone beyond the scope of the Board's recommendations to make changes and improvements to ensure out best efforts. All of this has cost more than the original estimate because at that time we could not identify the technical solutions needed.

Shortly after the Board issued its report, we issued NASA's *Implementation Plan for Space Shuttle Return to Flight and Beyond,* in September 2003. We announced that we would update the plan regularly to reflect on-going development. On August 30, 2004, we issued the latest update, the sixth revision of the Plan. Throughout the past year these revisions report up-to-date status. This plan details the current tasks and cost estimates for RTF activities to safely return the Space Shuttle to flight. In addition to providing updates on NASA's progress toward RTF, the implementation plan recognizes the importance of RTF as the first step toward the long-term goals of exploration outlined in the Vision for Space Exploration. The updated implementation plan shows that NASA continues to make progress in all efforts to make the Shuttle safer. The revised schedule for implementing the Board's recommendations demonstrates that NASA has a deliberate approach for achieving all necessary milestones required to close each action item.

We have pursued our RTF plans in a purposeful manner, our progress has been steady, and we are optimistic that the launch of Discovery will occur during the window of opportunity in March through April next year. However, our RTF plans continue to be based on accomplishing milestones and are not driven by meeting a specific launch window. Consistent with this approach, NASA will comply with all fifteen RTF recommendations from the Board prior to launch. The RTF Task Group, chaired by former astronauts Richard Covey and Thomas Stafford, is charged with assessing the implementation of these recommendations. The Task Group, as of July 22, 2004, has conditionally closed five RTF recommendations. Our current plan is to close the remaining ten RTF recommendations by the end of 2004. The five recommendations that have been conditionally closed are:

Recommendation 3.3–1—Develop and implement a comprehensive inspection plan to determine the structural integrity of all Reinforced Carbon-Carbon (RCC) system components. This inspection plan should take advantage of advanced non-destructive inspection technology. To close this recommendation, NASA has cycled all Orbiter RCC Wing Leading Edge panels and nose cones through the vendor for inspection and confirmation of structural integrity.

Recommendation 4.2–3—Require that at least two employees attend all final closeouts and intertank area hand-spraying procedures. To close this recommendation, NASA's procedures have been changed to require a minimum of two technicians be present for all final vehicle closeout operations, even with completion of critical closeout procedures during manufacturing and assembly.

Recommendation 4.2–5—Kennedy Space Center Quality Assurance and United Space Alliance must return to the straightforward, industry-standard definition of "Foreign Object Debris," and eliminate any alternate or statistically deceptive definitions like "processing debris." To close this recommendation, NASA has ceased using the term "processing debris" and has changed all work procedures to treat all debris at the same high level.

Recommendation 6.3–2—Modify the Memorandum of Agreement with the National Imagery and Mapping Agency [now the National Geospatial-Intelligence Agency (NGA)] to make the imaging of each Shuttle flight while on orbit a standard

requirement. To close this recommendation, NASA has agreements with NGA and other government agencies to receive support using appropriate national assets.

Recommendation 10.3–1—Develop an interim program of closeout photographs for all critical sub-systems that differ from engineering drawings. Digitize the closeout photograph system so that images are immediately available for on-orbit troubleshooting. NASA has revised the vehicle processing procedures to mandate that closeout photography be performed and has implemented enhancements to the Still Image Management System to allow more efficient distribution of closeout photographs to support on-orbit troubleshooting.

NASA has embraced the Gehman report and is committed to complying with all the Board's recommendations, as well as self-initiated "raise the bar" actions to improve safety that go above and beyond the content of the Board's recommendations. In addition to the Board's recommendations, the Space Shuttle program is working fifteen self-imposed actions and directives. Of these "raise the bar" initiatives, the RTF Task Group has elected to review Space Shuttle Program Action 3, Contingency Shuttle Crew Support (CSCS). The CSCS capability could, in an emergency, sustain a Shuttle crew onboard the ISS for a limited time to enable a repair to the orbiter or allow the crew to be returned to Earth via a rescue mission. The Space Shuttle and ISS programs have made progress in defining and planning for a CSCS capability. The two programs have completed analyses that indicate that, for our first two flights at a minimum, it is possible to launch a rescue mission during the time that the Shuttle crew can be safely sustained on the ISS. Other "raise the bar" initiatives include review of processes, hardware and activities or analyses that we believe will make the Shuttle safer. These include analysis and testing to determine critical debris sources, improvements to the flight readiness review process, removal and refurbishment of the orbiter rudders speed brake actuators, radar coverage capabilities and requirements, and hardware processing and operations.

We continue to make significant progress in understanding the debris environment and the material characteristics of the orbiter and External Tank Thermal Protection System (TPS). As a result, we are able to better target critical areas for hardening prior to RTF. Even more critical to our ability to return safely to flight, we have made significant progress in reducing the foam debris that is shed from the External Tank during ascent. Work to develop viable repair techniques and materials for the orbiter TPS is under way, and progress has been made on repairing acreage tiles and Reinforced Carbon-Carbon cracks.

As our efforts to return the Space Shuttle to safe flight have matured and the required work has been identified, NASA has gained a better understanding of the costs associated with this challenging endeavor. Along with the tasks required for RTF, we have reinvigorated our safety and engineering practices. As a result, we have continued to identify safety-related issues that require additional work. Earlier cost estimates presented in previous revisions of the Implementation Plan could not have included all RTF elements now under consideration. Nor did they address additional requirements that might be derived from our continuing evaluation of the Board's recommendations, or costs incurred by other agency activities in support of RTF. The current cost estimate, submitted to the Committee on July 30, takes into account all currently known potential costs, except a budget reserve. This estimate will also change to address new challenges that may arise after the first two flights in 2005.

NASA's updated estimates for RTF activities are as follows:

FY 2003—$42 million
FY 2004—$465 million
FY 2005—$643 million (includes $309 million remaining "under review")

NASA's updated RTF estimates through FY 2005 are reflected in Enclosure 1.

The updated FY 2003 estimate of $42 million reflects actual expenditures and the migration of planned work from FY 2003 into FY 2004. The updated FY 2004 estimate of $465 million reflects the continuing refinement of our RTF plan, better technical definition of the work to be accomplished, and better cost estimates for the work. Our estimates for the remaining years are based on our experience to date, which is still evolving. Through the early part of 2004, the pace of NASA's RTF technical efforts accelerated rapidly. We moved from planning to execution very quickly, and began to close on some of the multiple paths we initiated in late 2003. But there is still a great deal of work ahead, and we are still refining our technical solutions and our cost estimates. As we do and the content is better defined and understood, the budget projections will likely change again. They will also change in 2005 as we launch the Space Shuttle and assess the information gained by actual flight experience.

The *Columbia* experience has moved us to reassess the Space Shuttle program in total. As a result, we are introducing a higher level of engineering and technical rigor into all of our safety and engineering processes and practices. Many potential flight risks have been reevaluated and mitigated, resulting in what we believe is a safer Shuttle system overall. Across the board, flight hardware is now subjected to greater levels of test, tear-down, inspection, repair, and recertification for flight, and all elements of the program are reassessing the adequacy of industrial processes, safety controls, integrated hazard analyses, and flight hardware test protocols.

When we return to flight, we believe the Space Shuttle will be safer, but we will never eliminate the risk. We are confident in our ability to maintain a renewed level of safety standard throughout the life of the Space Shuttle program. We have the best and brightest in NASA and industry working diligently to overcome the challenges of returning the Shuttle safely to flight. Although there will most likely be additional challenges before *Discovery* takes flight, the NASA and contractor team are confident that the Space Shuttle program can safely accomplish its role in the Vision for Space Exploration to complete International Space Station assembly. As John Kennedy so eloquently said more than forty years ago, "We choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard." We are committed to the safe return to flight—the first step toward the renewed NASA mission to explore the universe.

Thank you again for the opportunity to appear before you today, and I look forward to any questions that you may have.

Enclosure 1

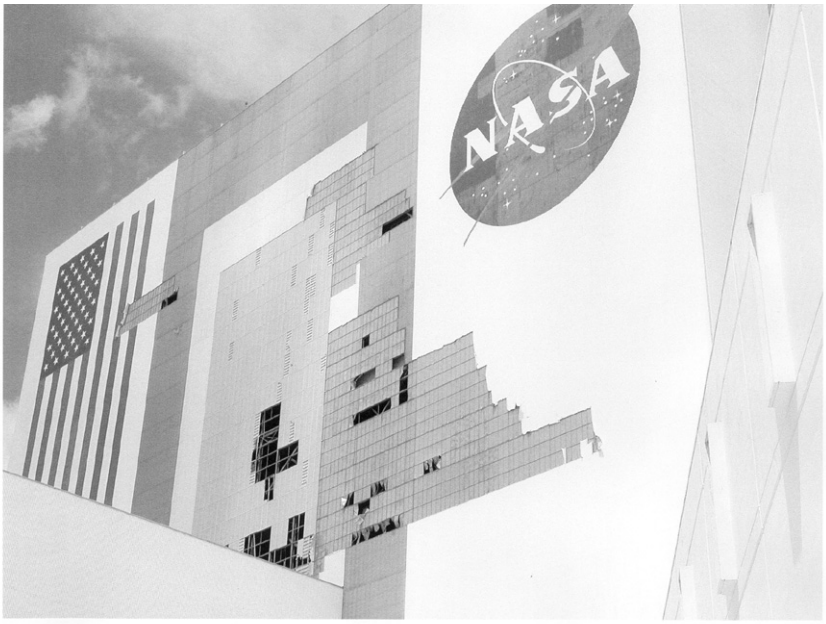
	FY 03	FY 04	FY 05
TOTAL RTF	**42**	**465**	**643**
RTF Activities - approved/paperwork complete	31	319	117
RTF Activities - tentatively approved/paperwork outstanding	11	146	217
RTF Activities - In Review Process	0	0	309
RTF Activities - Control Board Directive	**31**	**319**	**117**
Orbiter RCC Inspections & Orbiter RCC-2 Shipsets Spares	2	38	0
On-orbit TPS Inspection & EVA Tile Repair	20	68	34
Orbiter TPS Hardening		28	1
Orbiter Certification / Verification		47	
Orbiter Other (GFE/Contingency)		15	16
External Tank Items (Camera, Bipod Ramp, etc.)		6	1
SRB Items (Bolt Catcher, ETA Ring Invest., Camera, other)	1	8	
Ground Camera Ascent Imagery Upgrade	8	40	3
Rudder Speed Brakes		5	11
Other (System Intgr. JBOSC Sys, Full Cost, Additional FTEs, etc.)		62	50
Return to Flight Task Group (Stafford-Covey Team)	0	3	1
RTF Activities - Been to Control Board/No Directive	**11**	**146**	**217**
Orbiter Workforce (Ground Ops)		5	5
External Tank Items (Camera, Bipod Ramp, etc.)	11	109	92
Ground Camera Ascent Imagery Upgrade			52
Orbiter Workforce (Ground Ops, USA, Boeing, Logistics Eng.)			32
KSC Ground Ops Workforce		32	36

	FY 03	FY 04	FY 05
RTF Activities - In Review Process	**0**	**0**	**309**
Orbiter RCC Inspections & Orbiter RCC-2 Shipsets Spares			
On-orbit TPS Inspection & EVA Tile Repair			
Orbiter TPS Hardening			
Orbiter Certification / Verification			
SRB Items (Bolt Catcher, Camera, other)			
Ground Camera Ascent Imagery Upgrade			
Increased SSME Testing			
SSME CAIB Impacts			
Other (System Intgr. JBOSC Sys, Full Cost, Additional FTEs, etc.)			

TPS—The mangled steel roof from the Thermal Protection System (TPS) Facility, where Space Shuttle tiles and blankets are manufactured, lies next to the structure. The interior of the facility is exposed to the elements. Initial assessments indicate that the work normally done at the TPS Facility may be accomplished at another location.

TPS Interior—The interior of the Thermal Protection System (TPS) Facility, where Space Shuttle tiles and blankets are manufactured, was exposed after a large section of the roof was torn away by Hurricane Frances over the Labor Day weekend. Work is under way to recover critical space flight material, such as tile molds, from exposed areas.

VAB—The massive Vehicle Assembly Building (VAB) at NASA Kennedy Space Center lost about 820 panels during Hurricane Frances. None of the equipment inside the building, was seriously damaged. The VAB is 525 feet tall and is covered by nearly 1,100,000 square feet of insulated aluminum panels and 70,000 square feet of plastic panels.



VAB—The massive Vehicle Assembly Building (VAB) at NASA Kennedy Space Center lost about 820 panels during Hurricane Frances. None of the equipment inside the building, was seriously damaged. The VAB is 525 feet tall and is covered by nearly 1,100,000 square feet of insulated aluminum panels and 70,000 square feet of plastic panels.

Grandstands—The roof protecting the viewing stands near the Kennedy Space Center press site was blown away during Hurricane Frances. In the background is the Vehicle Assembly Building, which also suffered significant exterior damage during the weekend storm.

Senator BROWNBACK. Thank you very much, and I look forward to some of our discussion.

General Stafford, thank you very much for joining us. The floor is yours.

STATEMENT OF LIEUTENANT GENERAL THOMAS P. STAFFORD, U.S. AIR FORCE (RETIRED), CO–CHAIRMAN, RETURN TO FLIGHT TASK GROUP; ACCOMPANIED BY JOSEPH W. CUZZUPOLI, MEMBER, RETURN TO FLIGHT TASK GROUP

General STAFFORD. Mr. Chairman and members of the Committee.

Senator BROWNBACK. Get one of those microphones a little closer to you, if you would.

General STAFFORD. Mr. Chairman——

Senator BROWNBACK. Thank you.

General STAFFORD.—and members of the Committee, thank you for the opportunity today to appear before you to discuss the status of the Return to Flight Task Group's assessment.

I have a written statement that I'd like to submit, with your permission, Mr. Chairman, at this time.

Senator BROWNBACK. It will be accepted in the record.

General STAFFORD. Thank you.

In July 2003, the NASA Administrator, Mr. O'Keefe, chartered a group under the Federal Advisory Committee Act to perform an independent assessment of the agency's actions to implement the recommendations of the *Columbia* Accident Investigating Board,

the CAIB, as they relate to the safety and to the operational readiness of STS–114. The Task Group today consists of 26 members from industry, from academia and government. Some key members also serve on the NASA Advisory Council Task Force on the International Space Station for Operational Readiness, which I chair. Also, two serve on the NASA Advisory Aerospace Safety Panel. All members bring with them recognized knowledge and expertise in a variety of the relevant fields for this task.

I have with me today, Mr. Chairman and members of the Committee, the leaders of the Task Group, three panels. Dr. Dan Crippen, who heads our management panel. He has a strong reputation for objective and insightful analysis. A lot of you know him. Mr. Joe Cuzzupoli, who leads the technical panel. Mr. Cuzzupoli has had more than 40 years of aerospace experience and management experience. Colonel Jim Adamson, who is the leader of the operations panel. Colonel Adamson is a former astronaut. He has an extensive background in aerodynamics, operations, and business management. These gentlemen's impressive background is submitted with the record. And they are deeply involved in the Task Group's activities on a daily basis, and they will be available to answer the specific details of your questions.

And since August of 2003, the Task Group has conducted extensive fact-finding activities at all levels within the NASA agency and at the contractor team. The members have visited NASA and the contractor facilities, participated in their teleconferences. We've reviewed documents, conducted interviews, received briefings, observed test simulations and program reviews. And also, Mr. Chairman, when appropriate, members of the Task Group have interviewed and talked with former CAIB members.

The Task Group, to date, has conducted four open public meetings in which they reviewed NASA's progress. We have issued two interim reports. And the next interim report now is scheduled for October.

The Task Group is encouraged by NASA's progress. We've observed the people of NASA are engaged and dedicated to correcting the deficiencies that led to the *Columbia* accident. We believe that NASA has made substantial progress in many, many areas. At the same time, we believe the agency faces significant challenges ahead and has considerable work ahead of it in some areas before it will be ready to fly again.

To date, the Task Group has formally assessed and conditionally closed five of the 15 recommendations from the CAIB. I want to assure this Committee that the Task Group will continue to monitor NASA's progress and the implementation of these recommendations as we work to fully close each one.

Now, looking at some of the challenges, the Task Group believes NASA's most important work is efforts to eliminate the critical asset debris—*i.e.*, the shedding of debris from that external tank. The agency has made considerable progress in this area. If it could be ensured that no critical debris would come from the external tank, the immediate cause of the loss of *Columbia* would certainly be rectified. While analytical and testing techniques will allow a level of comfort before launch—and advances in the non-destructive inspection techniques may add some confidence to this—it'll still be

impossible to guarantee no critical debris would be shed. Additionally, it may not be possible to obtain statistically significant data verifying external tank conditions even by the end of the Shuttle program.

Therefore, on-orbit inspection and repair capability remain necessary to reduce the risk to future flights. And since our last report, it's become apparent that NASA continues to face some technical challenges in developing these capabilities.

Now, I might report, Mr. Chairman, that even in the last 2 weeks, there has been significant progress made in the sensors to inspect in-flight onboard the Shuttle.

Should one or both of these capabilities not be sufficiently developed by the Shuttle's Return to Flight, the potential for a crew to await a rescue mission at the International Space Station becomes the logical consideration for the next launch. Therefore, the Task Group is starting to assess this safe-haven capability.

A universal concern of the Task Group is the personnel requirements to meet the CAIB recommendations for Return to Flight. The new engineering and safety organizations that are being established at NASA all require talented individuals. And right now they're largely drawn from the current NASA and contractor pool.

In summary, the Task Group believes that although significant work lays ahead, NASA has made substantial progress toward meeting the CAIB's recommendations. And I want to assure the Committee that the Task Group remains engaged, they'll be aggressive in their fact-finding, and will continue to thoroughly assess and publicly report on NASA's progress toward meeting the intent of the *Columbia* Accident Investigation Board.

And I appreciate the opportunity to discuss the work of the Return to Flight Group with you this morning. Colonel Adamson, Mr. Cuzzupoli, Dr. Crippen, and myself now look forward to responding to your questions.

Thank you, Mr. Chairman and members of the Committee.

[The prepared statement of General Stafford follows:]

PREPARED STATEMENT OF LIEUTENANT GENERAL THOMAS P. STAFFORD, U.S. AIR FORCE (RETIRED), CO-CHAIRMAN, RETURN TO FLIGHT TASK GROUP; ACCOMPANIED BY JOSEPH W. CUZZPOLI, MEMBER, RETURN TO FLIGHT TASK GROUP

Mr. Chairman and members of the Committee, thank you for the opportunity to appear before you today to discuss the status of the Return to Flight Task Group's assessment activities.

In July 2003, the NASA Administrator chartered the group, under the Federal Advisory Committee Act, to perform an independent assessment of the agency's actions to implement the recommendations of the *Columbia* Accident Investigation Board (CAIB) as they relate to the safety and operational readiness of STS–114.

The Task Group consists of 26 members from industry, academia, and government. Some key members also serve on the NASA Advisory Council's International Space Station Operations Readiness Task Force, which I chair. And two serve on the Aerospace Safety Advisory Panel. All of our members bring with them recognized knowledge and expertise in a variety of relevant fields.

The Task Group is organized for fact-finding into three panels—Management, Technical, and Operations. I have with me here today the leaders of these three panels.

No stranger to many of you, Dr. Dan Crippen, who leads our Management Panel, has a strong reputation for objective and insightful analysis. He is the former Director of the Congressional Budget Office, has served as Chief Counsel and Economic Policy Adviser to the U.S. Senate Majority Leader, and Domestic Policy Advisor and

Assistant to the President for Domestic Affairs. Dr. Crippen is also a member of the Aerospace Safety Advisory Panel.

Mr. Joseph Cuzzupoli, leader of our Technical Panel, brings to the Task Group more than 40 years of aerospace engineering and managerial experience. Presently Vice President and K–1 Program Manager for Kistler Aerospace Corporation, he was Vice President and Program Manager for the Space Shuttle Orbiter Project for Rockwell International during its design, development, and initial operations, and was an Assistant Program Manager on Apollo. He is a current member of the ISS Operational Readiness Task Force.

Colonel James Adamson, the Task Group's Operations Panel leader, has an extensive background in aerodynamics and operations as well as business management. He is a former astronaut with two Space Shuttle missions to his credit. He has served as President of Allied Signal Systems Technical Services, a government services company which later became Honeywell, and was one of the founders and the first Chief Operating Officer for United Space Alliance. He is currently CEO of his own consulting firm, Monarch Precision, and a member of the ISS Operational Readiness Task Force.

These three gentlemen have been deeply involved in the Task Group's activities and will be available to answer the details of your questions.

Since August of 2003, the Task Group has conducted extensive fact-finding activities at all levels within the agency and its contractor team.

Task Group members have visited NASA and contractor facilities, participated in teleconferences, reviewed documents, conducted interviews, received formal and informal briefings, and have observed tests, simulations, and program reviews.

In all, to date, the Task Group has conducted approximately 100 formal fact-finding activities and has issued more than 90 formal requests for information to the Space Shuttle Program Office.

Throughout the process the Task Group has, when appropriate, consulted with former members of the CAIB to ensure our members fully understand the intent of their recommendations.

The Task Group has conducted four public meetings at which it reviewed NASA's progress in meeting the intent of CAIB and the group has issued two interim reports. The next public meeting will take place in Houston next week and another interim report is planned for October.

Based on these extensive activities, I can report to you today that the Task Group is encouraged by NASA's progress, and as we said in our last report, we have observed that throughout the organization the people of NASA are engaged and dedicated to correcting the deficiencies that led to the *Columbia* accident.

We believe that NASA has made significant progress in many areas. At the same time, we believe that the agency continues to face significant challenges and has considerable work ahead of it in some areas before it will be ready to return the Shuttle to flight.

Over the last several months, the Task Group has formally assessed and conditionally closed 5 of the CAIB's 15 Return to Flight recommendations. This means that based on its independent fact-finding and deliberations, the Task Group believes that, contingent on the agency meeting some specific additional conditions, NASA will have met the intent of these 5 CAIB recommendations.

I would like to briefly address each of these recommendations.

The Task Group believes that NASA has conditionally met the intent of CAIB Recommendation 3.3–1 in its development and implementation of a comprehensive inspection plan to determine the structural integrity of all Reinforced Carbon-Carbon (RCC) system components. And that the inspection plan takes advantage of advanced Non-Destructive Inspection (NDI) technology.

In satisfying CAIB Recommendation 3.3–1, NASA has:

- Requested the manufacturer to rebaseline all RCC system components.
- Undertaken development of new NDI methods for RCC inspection: thermography, X-ray, and eddy current techniques.
- Begun incorporating new methods of NDI into existing field processes.

Prior to fully closing this recommendation, the Task Group wants to see completion of requirements documentation and directives, and the results of some additional testing.

We believe that the agency has conditionally met the intent of CAIB Recommendation 4.2–3 to require that at least two employees attend all final closeouts and intertank area hand-spraying procedures. In fact this commitment has been expanded to include all flight hardware closeouts.

In satisfying CAIB Recommendation 4.2–3, NASA has:

- Amended all manufacturing processes and procedures to ensure that at least two employees are present at all manufacturing steps.
- Incorporated more stringent quality assurance requirements through additional employee training, certification, and procedures for inspections and imagery.

Before fully closing this item, the Task Group is awaiting completion of requirements documentation and directives, and the results of a program-wide audit.

The Task Group believes that NASA has conditionally met the intent of CAIB Recommendation 6.3–2 to modify the Memorandum of Agreement with the National Imagery and Mapping Agency—now the National Geospatial Intelligence Agency—to make the imaging of each Shuttle flight while on orbit a standard requirement.

In satisfying the intent of CAIB Recommendation 6.3–2, NASA has:

- Modified Memorandum of Agreement with the National Geospatial Intelligence Agency to request all available data that may assist NASA in the resolution of investigations.
- Implemented an Interagency Operating Agreement.
- Obtained necessary security clearances for appropriate positions.
- Developed plans to demonstrate new capabilities in simulations.

Prior to fully closing this recommendation, the Task Group is awaiting the assessment of simulation results.

We believe that NASA has conditionally met the intent of CAIB Recommendation 4.2–5 by returning to a straightforward, industry-standard definition of "Foreign Object Debris" (FOD) and eliminating any alternate or statistically deceptive definitions like "processing debris" by the Kennedy Space Center Quality Assurance and United Space Alliance.

In satisfying CAIB Recommendation 4.2–5, NASA has:

- Adopted FOD definition derived by National Aerospace FOD Prevention, Inc.
- Eliminated the term "processing debris."
- Conducted benchmarking to determine industry and government best practices and analysis on FOD handling.
- Completed workforce training on new definition and procedures.

Before fully closing this item, the Task Group is awaiting NASA's completion of FOD process audits and interviews.

And, the Task Group believes that the agency has conditionally met the intent of CAIB Recommendation 10.3–1 by developing an interim program of closeout photographs for all critical sub-systems that differ from engineering drawings and by digitizing the closeout photograph system so that images are immediately available for on-orbit troubleshooting.

NASA's actions to satisfy CAIB Recommendation 10.3–1 include:

- Established a more precise definition of "closeout photography" and strengthen general closeout requirements.
- Mandated that all digitized closeout photography be entered into a common closeout database system.
- Implemented enhancements to the closeout database system.
- Implemented photography steps in work procedures.
- Upgraded digital photography equipment and developed user training and photography certification.

Prior to closing this recommendation, the Task Group is awaiting the results of simulations to demonstrate that the database can be accessed in a timely manner by appropriate personnel, the completion of photographer training, and development of a database system familiarization course and computer-based training.

I want to assure this Committee that the Task Group will continue to monitor NASA's implementation of these recommendations and that we expect the agency to advise the Task Group if there is any material change in the status of any recommendation.

Looking ahead, at our public meeting next week the Task Group plans to consider NASA's request for closure of a sixth recommendation, 7.5–3, which calls for NASA to reorganize the Space Shuttle Integration Office to make it capable of integrating all elements of the Space Shuttle program, including the orbiter.

Our fact-finding activities indicate that NASA continues to make progress with the other recommendations as well and we anticipate several of them will be brought to us for formal assessment by the Task Group in the next month or two.

In April 2004, the Space Shuttle Program Office Safety and Mission Assurance Manager described for the Task Group a framework for reducing the risk from thermal protection system debris. The primary hazard control in the framework is the elimination of critical debris shedding. Should the primary control not be completely satisfied, the capability to detect impacts during ascent and to detect impact damage on-orbit provides warning devices. The ability to make on-orbit repairs to tile and RCC, and—as a last resort—crew rescue, provides special mitigating procedures.

The Task Group indicated in its last report that it is satisfied with this "top-down" approach as it is applied to this hazard reduction program. We have said that we believe that this same "top-down" approach needs to be implemented across NASA as a whole and specifically to all NASA Implementation Plan items.

Now, looking at some of the challenges, the Task Group believes—as stated in its last report—that NASA's most important work is its efforts to eliminate critical ascent debris and the agency has made considerable progress in this area. If it could be guaranteed that no critical debris would come from the External Tank, the immediate cause of the loss of *Columbia* would be rectified. Analytical and testing techniques will allow a level of comfort before launch. Advances in NDI techniques may add confidence. Still, to guarantee that no critical debris will be shed is impossible short of extensive testing in flight. However, it may not be possible to obtain statistically significant data verifying External Tank debris conditions even by the end of the Shuttle program. Therefore, on-orbit inspection and repair capabilities remain necessary to reduce the risk to future flights. Since our last report, it has become apparent that NASA continues to face some technical challenges in fully developing these capabilities. Should one or both of these capabilities not be sufficiently developed by the anticipated date of Return to Flight, the ability for the crew to await a rescue mission at the ISS will become an important consideration for the next launch. Therefore, the Task Group is assessing this "safe haven" capability.

A universal concern of the Task Group is the personnel requirements to meet the CAIB recommendations and return to flight. The various new organizations, from the NASA Engineering and Safety Center to the Independent Technical Authority to the Space Shuttle System Engineering and Integration Office, all require talented staff drawn largely from the current NASA and contractor pool.

In summary, the Task Group believes that although significant work lies ahead, NASA has made substantial progress toward meeting the intent of the CAIB's Return to Flight recommendations. On Aug. 26, 2003, following the release of the CAIB report, we stated publicly that, "the Return to Flight Task Group is committed to doing its part to help ensure the Shuttle returns safely to space by making a careful, thorough, and independent assessment of NASA's Return to Flight plans." I want to assure this Committee that the Task Group remains engaged and aggressive in its fact-finding and we will continue to carefully and thoroughly assess—and publicly report on—NASA's progress toward meeting the intent of the CAIB. I appreciate the opportunity to discuss the work of the Return to Flight Task Group with you. Colonel Adamson, Mr. Cuzzupoli, Dr. Crippen, and I now look forward to responding to your questions.

Senator BROWNBACK. Thank you very much, General.

And we'll proceed to a round of questions of 5 minutes each, and go by order of arrival.

General, I want to make sure I understand what you're saying here, then. You're saying that we are not going to be able to remove the falling of debris from the takeoff, which is what—when we held these original hearings, Mr. O'Keefe, people said, "This is going to be really tough to stop." You're saying we're not going to be able to stop the falling of debris, so we're going to go to reducing debris, and second, then, either an in-flight repair option or a rescue option in space. Is that correct?

General STAFFORD. Mr. Chairman, NASA has made considerable progress in eliminating large areas that could be shed, and we're doing—continuing testing on analytical areas, and this is an ongoing process. But there can be no guarantee that—or certification—that a critical piece will not come off, even though we're certifying certain parts of the vehicle, there would be a minimum piece for

certain areas, certain angles. And Mr. Cuzzupoli has followed this on a day-to-day basis, and he can give you up-to-date information on that. And most of it occurs in the first parts of the launch phase, when you have maximum aerodynamic pressure and heating there on the spacecraft. And if you want any sub-details, Mr. Cuzzupoli can certainly give you that.

Now, also, as we said, we are continuing on for the inspection and repair. There are certain areas that it looks like we could repair either cracks or holes up to a certain criteria. Also, the inspection capability is increasing every week. We don't know that we can have a complete, 100 percent—again, Mr. Cuzzupoli is up to the day-to-day technical details on that. And we're starting to assess the safe haven of the International Space Station for a rescue mission, Mr. Chairman.

Mr. O'KEEFE. Mr. Chairman, if I could just quickly add to that, I think exactly as General Stafford has described, the objective here is to eliminate the critical debris that could cause a catastrophic loss of the orbiter. And so, as a consequence, that has been isolated to determine exactly what would constitute that kind of a condition. What's been the case since the very first flight, and all the way up to the last, is a flaking effect that occurs with insulation. It's much like you'd see on any other kind of, you know, insulated case where there is a foam kind of exterior or something. Given the circumstances and the intensity of the heat and so forth, the objective is to eliminate the critical items of departure from the external tank itself, and that's what we're trying to work our way through. And I think we've developed a design that eliminates that prospect.

That said, what we've done is tested every one of those scenarios. I mean, not just put it through a computer model; we've literally gone through the effort of looking at varying kind of scenarios and shooting the foam at leading edges to determine exactly what the consequence will be. So this is not something we're speculating on or just running through some model; it's actually being conducted as a test to determine, what can the orbiter withstand?

I'm reminded of a comment that Admiral Gehman offered during the course of the investigation on several occasions, which is, "This is one tough piece of machinery." And the issue is to determine exactly what point, at what stage, does that tough piece of machinery take a catastrophic hit? And that's exactly what I think the Task Group has helped us to sort through and make sure we isolate as a condition.

Senator BROWNBACK. Well, that leads to my next question on this. According to our staff report on this, Return to Flight, to date—well, in July of this year we had projected it was going to cost $1.1 billion; that's now been upped to $2.2 billion in the July 2004 report of NASA to this Committee and to others, double the cost to Return to Flight. You've done five of the 15 items that are required, so you've got ten more yet to go and to check through. What's this going to cost? Are we anywhere close to really knowing what this is actually going to cost to get the Shuttle to return to flight?

Mr. O'KEEFE. This is—you know, again, the primary consequence of the changes that have occurred here in the overall projections—

and this is over a span of time; just not concentrated in Fiscal Year 2005 exclusively—is a combination of two events. The first one is, again, there are going to be sustaining engineering expenses necessary. What the Accident Investigation Board pointed out and observed and made as part of their recommendations is, you've got to have a more robust capacity, organizationally, to deal with this——

Senator BROWNBACK. Yes, I don't mean to cut you off, but my time's really short. Are we confident that the $2.2 billion will be the ultimate cost of Return to Flight?

Mr. O'KEEFE. Getting a lot closer, that's for sure. And I think the primary components of what contributed to these particular cost projections are, again, the induction of all three orbiters into a orbiter modification program right now, the effort to put on a series of sensors on every single one of the orbiters. There's a whole range of things we did not contemplate a year ago that we're doing now. So I don't see any new unknowns coming down the road. Whether or not this adjusts by some fraction or amount is almost a certainty, given the dynamics of this. But I don't see this as being a large increase differential in the time ahead, because the changes are primarily contributed to the options we picked.

Senator BROWNBACK. And the date? Do you still believe we will return to flight in spring of 2005?

Mr. O'KEEFE. Looking promising. I certainly wouldn't want to put a date-time group on it, by any means. We're going to make sure that when we've met these milestones, that's when we're fit to fly, and that's the occasion on which it'll occur. And it looks like it's tracking toward a spring opportunity.

Senator BROWNBACK. Well, now, I agree with that. We don't want to go to flight until it's ready and safe.

Mr. O'KEEFE. Yes, sir.

Senator BROWNBACK. General, you had a——

General STAFFORD. Mr. Chairman, I say that in our interface with NASA, the Return to Flight Task Group has observed that, really, NASA is milestone-driven and not schedule-driven. Certainly, you have to have a schedule out there for a planning factor, but we're anticipating that most of our task will be finished by December. Again, it has to be a milestone to complete that.

Senator BROWNBACK. I agree with that.

Senator Nelson?

Senator NELSON. Thank you, Mr. Chairman.

Mr. Administrator, what do you think will be the cost of repair at the Kennedy Space Center?

Mr. O'KEEFE. Don't know, sir. We just did get an assessment team on the ground here at about 5 o'clock on Labor Day, so here roughly—you know, less than 48 hours ago, we really got into the intensity of looking at what the assessments are. But we're anxiously working that through right now.

Senator NELSON. Well, here's the timing on that.

Mr. O'KEEFE. Yes, sir.

Senator NELSON. We just passed $2 billion last night. That's not even going to cover it for Charley. I'm expecting at least an additional $2½ billion that the Majority Leader has said he is willing to come forward with next week. Now, whether or not that's going

to be a part of the homeland security bill or whether or not we have to strip it off depends on whether or not homeland security gets mired down in a whole bunch of other questions.

The fact is that, as of today, FEMA is running out of money, so that's why they had to have the action that occurred last night. Now, if you go back to the experience that we had with Andrew, there was almost a billion dollars that was appropriated to the Department of Defense because of the destruction to Homestead Air Force Base. So what I'm saying is, strike while the iron is hot. Instead of you having to take this out of your budget, this is an opportunity to get money, because you've obviously sustained some serious damage. And so we need an estimate so that we can roll it into all of these other requests that we're getting from the Department of Agriculture and so forth and so on.

Mr. O'KEEFE. Yes, sir. This is a tragedy, and we are assessing what the scope of that tragedy is. We're working with our colleagues in the Administration to make a determination of that, and we'll be back promptly.

Senator NELSON. Now, could you comment, when we see a photograph, like that, of the TPS facility, and winds of only 120 miles an hour, gusts, hit the Cape, and it does that kind of damage to a facility that the entire space program is dependent upon the production of these thermal protective system tiles, you can imagine what 145 miles an hour would have done when you look at what 120 miles per hour did to that facility. In your calculation on repair, it seems to me that there were mistakes made in designing the strength of these buildings to withstand the wind and, in the repair and renovation, that we've got to move to that higher standard, that it's too important for the future of the space program. Would you calculate that in your request for repair money?

Mr. O'KEEFE. Yes, sir. We'll take a look at all the different variations of what's involved here. Again, I think, given the strength and ferocity of this hurricane, the fact that the Kennedy Space Center rode this through in the manner in which it did—all three orbiters are in great condition, the Space Station hardware was not affected, the satellites that are there, due for launch, were protected—this was really quite a story. I think Jim Kennedy and the team at the Kennedy Space Center did a spectacular job of really, really preparing for the worst circumstance.

There was going to be damage. And, again, I—you know far better than I do, in terms of firsthand evidence of exactly what the consequences across the state have been. The fact that the Kennedy Space Center withstood this kind of damage, this kind of intensity, and rode it out in a manner that was the least problematic is really a testimonial to the professionalism of the team down there. They did a spectacular job.

Senator NELSON. Do you have an answer as to why there were not backup generators in the three OPFs?

Mr. O'KEEFE. You know, I heard you mention that at the opening statement, and I've been inquiring here. We had all three of the Orbiter Processing Facilities, the orbiters were powered down before the hurricane struck. The objective was to minimize that damage. We did lose power in OPF—the Orbiter Processing Facility number three, which is where *Discovery* was under repair. Why

that generator didn't kick in, as it did with the other two, is something we'll have to run to ground. I don't know the answer to the question, but I'll find out.

[The information referred to follows:]

During preparations For Hurricane Frances last week (Thursday, September 2, 2004), there was a prediction that Frances could become a Category 5 hurricane. When conditions reach such severe levels, KSC's Hurricane Plan calls for the ride-out crew to evacuate the Center and gather at a safe location in Titusville. As the ride-out crew leaves the Center in this case, they are instructed to remove facility power (*i.e.*, throw the breakers), which would have left the facilities on back-up generators and uninterruptible power supplies (UPS). Because of concerns with potential storm surge with a predicted Category 5 hurricane, the decision was made to leave the power applied to the Orbiter Processing Facilities (OPF) but to shut down the back-up generators and UPSs so that if power was lost, they would not come on unattended. Normally, the ride-out crews would be in the Center and would have been able to monitor power and purge, dealing with any anomaly. When the ride-out crew left, all three OPFs had power and purges applied.

Upon return of the ride-out crew, the following was found:

- OPF #1—*Atlantis* power was down, along with the purge capability; the ride-out crew restored power and purges with no problems noted.
- OPF #2—*Endeavour* power was up and running and the purge capability was maintained throughout.
- OPF #3—*Discovery* power was up, but the purge was down (circuit breaker tripped). When the ride-out crew attempted to restart the purge capability to *Discovery*, cooling was not achieved and a hardware failure with the compressor was identified. It took the better part of a day to repair the compressor in OPF #3 and restore the purge to *Discovery*. It is not clear whether the purge breaker tripped due to a power problem or due to the compressor hardware failure. Had the ride-out crew been present, they might have been able to take action when power was lost in OPF #1 and the purge lost in OPF #3.

Senator NELSON. All right. If Ivan were to come to the Cape, what is the plan, given that photograph sitting on the floor, where you've got a thousand open windows into the VAB?

Mr. O'KEEFE. We're assessing that right now. We're hopeful that that will not be of the same intensity, but certainly it's going to be a more difficult circumstance if we were to be struck exactly the same again. I don't know what the assessment will be at this point, but let me find out.

[The information referred to follows:]

NASA's primary responsibility in the event of a hurricane is, first, to ensure to the greatest extent possible the safety of NASA civil servant and contractor personnel and, second, to take all practical measures to safeguard NASA equipment and facilities, many of which are unique and indispensable to the Nation's space program. The Kennedy Space Center (KSC), in conjunction with the Air Force's 45th Space Wing, has developed Hurricane Preparation and Recovery procedures that address NASA's obligation to balance safety-of-life concerns with the need to secure valuable assets during severe storms. However, safety is paramount. Lives will not be endangered to secure or service flight hardware, provide fire protection, security, repair, or fuel generators during severe storms.

KSC damage and recovery teams were on-site immediately after Hurricane Francis and had begun preliminary repairs to the Vehicle Assembly Building (VAB) in preparation for Hurricanes Ivan and Jeanne before Jeanne hit. The VAB lost 820 panels and a 5x12 foot roof panel during Hurricane Francis and a further 30 panels during Hurricane Jeanne. Preliminary repairs to the VAB have been completed; analysis indicates that these repairs should be sufficient to withstand sustained winds of up to 60 miles per hour. If a hurricane were to hit KSC with wind loads higher than 60 MPH then it is possible that the panels could have come off again. Crews will begin permanent repairs starting in November and will have them completed before the start of the 2005 hurricane season. Flight processing hardware inside the VAB suffered only minimal damage, and KSC personnel are confident that the facility will be ready to support Space Shuttle Return to Flight activities while the permanent repairs are being affected.

Senator BROWNBACK. Thank you.
Senator Lott?

STATEMENT OF HON. TRENT LOTT, U.S. SENATOR FROM MISSISSIPPI

Senator LOTT. Thank you, Mr. Chairman.

And thank you, Mr. Administrator. And, General, thank you for your service, and to your task force that you have with you.

Boy, it seems like one problem after another, and now you've got the hurricane to deal with. I do think it's a real good point, if that much damage was done with a 120-mile-an-hour wind, what if it had been 200 miles-per-hour, which we've seen hit certain parts of the Gulf Coast in the past? But I know you'll assess that damage as quickly as you can, and so that would be a part of the request the Administration will send.

You know, I am worried about safety, of course, but I also am worried about, you know, morale and direction within NASA. I mean, until we return to flight, you know, the thing that you really are meant to do is going to be on hold, and I'm worried about that.

I also am worried about—and I've discussed this with you—about some of the gaps between the launch systems, the one you have now and what you plan for the future, what that's going to do to the workforce. How are you going to deal with this? Are you going to expedite the decisions? Are you going to extend the time that we use the current launch systems? We've got a potential problem in the next few years.

In that connection, also, I think you've got a real problem with having more and more demands placed on you, and having to basically move money around. I understand, for instance, the Hubble Space Telescope supporters are pushing back, wanting more money. You're either going to have to ask for more money or you're going to have to move it from somewhere else, and you're starving a lot of other good programs.

So I really am concerned about NASA and our plan for the future, beyond just Return to Flight. What is our plan? I know that there is space exploration and going to Mars and all that, but there's a long way between where we are and getting there, and I'm worried about how we're going to pull that off.

I guess I asked a whole collage of questions there, but rather than giving you—asking you one after the other, why don't you just speak to the general propositions that I've laid out?

Mr. O'KEEFE. Yes, sir. No, I appreciate the sentiment, and I'll do my best to respond.

First and foremost, the President, on January 14th, issued what is the strategy, articulated that, submitted the budget 3 weeks later. So the first major step in that process has been accomplished.

The second step is for Congress to endorse that and to appropriate the funding that he's requested. That's our fondest expectation and hope, that the Congress can see their way clear to do that in this appropriations process, and we're confident that we can find our way clear to do that, which would accomplish much of what you've already referred to. It covers the Return to Flight challenges. There certainly are costs that we need to accommodate

within that, but I think we can accomplish that. We've certainly worked through a number of options and alternatives for that. And moving forward, we think what we've done here is prioritized the approach necessary in the President's budget request that was made in February to emphasize the priorities that he's directed in this strategy that was articulated.

So that's the process we are moving down the road on. There is nothing I see that's insurmountable. Certainly, the events of a hurricane and other things are constant new challenges that you've got to go wrestle with, but this is, you know, part of life, and there's no doubt about it, we're going to continue to wrestle with that. But there is nothing I see at this juncture that would make or compromise our capacity to accomplish the goals that he's laid out in those objectives.

And as it pertains to your first question, I believe, which was, what do we do in the longer term, in terms of retirement of Shuttle and then the beginning of the Crew Exploration Vehicle through Project Constellation, that occurs at the end of the decade. The immediacy of the challenges we face right now, the first one is Return to Flight in order to complete the International Space Station. We think we're on track to do that. New obstacles have mounted, but even those are surmountable, in terms of the kinds of challenges we're facing. And how we address the end of the decade is something we're going to continue to iterate. But in the meantime, nothing precipitous will be made in order to preclude any of the options necessary to assure a transition between those two programs.

Finally, I would just observe that the morale of the agency, from my assessment, has improved drastically by our focus on a mission objective. What the President delivered on January 14th is a focus, a set of priorities, a clear enunciation of what we do in this agency, and that's done more to improve the focus, attention, and morale of all of our colleagues than any other singular act. We're focused on the mission objectives. We're gonna get there.

Senator LOTT. One other concern that I have had for years—and I've pressed the point, I've discussed it with you, your predecessors—a vision for the agency is important for the workers, but to have the support of the American people, it's got to be more than that. They've got to see some tangible results. I've always argued, we get scientific, medical, technological, all kinds of benefits from our space program. The idea of just going to Mars doesn't, frankly, excite a lot of people in my state. They don't really care whether there's water up there or not. They'd rather have asphalt on their roads. But if you can show, or we can have a process of—or programs to get what you learn from that, the benefits, into the private sector, then you've got a deal. Don't forget that.

Mr. O'KEEFE. Yes, sir.

Senator LOTT. You know, just some esoteric visionary—spaceflight is not enough. And if NASA doesn't continue to focus on that sort of transfer and programs like the Earth sciences area, you're going to pay a price, because you're going to lose the support of the American people; and when you lose their support, then you lose our support.

Mr. O'KEEFE. Yes, sir.

Senator LOTT. And we need you to help us have the information and the ammunition and the technology and science transfers that show the people we're getting a great benefit. Do you want to respond to that?

Mr. O'KEEFE. Absolutely, Senator, I could not agree with you more. Every single dollar we spend on exploration is spent right here on this planet and, as a consequence, it has tangible benefits that go well beyond the scope of simply achieving those exploration goals. The technology we've developed just in recent years contributed to the development of cataract detection, heart pumps, all the different things that we see in day-in and day-out life that were a consequence motivated by the technology we developed.

We anticipate that as a consequence of pursuit of this strategy, we're going to see at least that and a whole lot more, because it's a motivation in order to develop those technologies for greater, broader applications. And we've certainly focused on that approach of how to categorize all those different consequences that are there. It is really quite astounding, and it's something—again, contributes to a much broader understanding of our technology development and economic improvements in this country, all by itself, in terms of where we progress, in terms of economic development efforts. That's had a tremendous consequence, and one we will continue to focus on as a preeminent priority in this particular effort.

Senator LOTT. Thank you, Mr. Chairman.

Senator BROWNBACK. Senator Hutchison?

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

Senator HUTCHISON. Thank you. Thank you, Mr. Chairman.

I think most of us up here are cosponsors of the reauthorization of NASA, along with the President's Vision to try to go forward. However, we're also—I, at least, am concerned about the potential gap in the CEV being ready and not having Shuttles for a year or so if we don't have a certified Shuttle. I was ready to offer an amendment to the bill, but was told that you didn't want the Shuttle to be re-certified in case there might be a gap. So I want to work with you, but I want to make sure that we're not going to have a gap that can't be overcome or that would stop the progress that we're making on the Station and the experiments that would be going. So how would you address that?

Mr. O'KEEFE. Absolutely. No, I thank you, Senator. We are delighted to work with you to accomplish that goal.

Our objective right now—again, as you've just alluded—is to complete the International Space Station. That is some 25 to 30 flights. We're continuing to work through the calculus of that. We've met with all the international partners and lined up all those modules. Whether that occurs, on what date, and what exactly will be the effect of that is going to be a consequence of time. How rapidly do we get back to Return to Flight?—and what the sequence of events could be. Any number of different things could alter that schedule.

At present, we're looking at something that will accomplish that task by the end of this decade. Our partners have signed off on

that. They're all in agreement that that does meet the objectives of each of us in the International Space Station partnership.

Along the way, too, we're concurrently developing, under Project Constellation, the Crew Exploration Vehicle. The response we've received in the broad agency announcement that was put out here just a few months ago has been overwhelming. We've gotten better than 1,200 different respondents, and have nicked that down now to about seven or eight major teams that are now moving forward. And what we're looking to is, by 2008, the development of the first spiral of Project Constellation, which will be an unmanned vehicle to be accomplished by that time. And it looks like we can accomplish this task.

There has been a remarkable interest from, not only the traditional aerospace interests and, kind of, industrial prowess that we see across this country, but a whole bunch of different companies and organizations and efforts that have gone into looking at this very differently. And achieving that by the end of this decade appears now to be within range of something people are excited about, they're ready to pursue. And all that stands in the way of achieving that task is the endorsement by the Congress of the President's budget request for this coming fiscal year. If we get that, we're on our way toward that task, and I think we can close that gap in the time ahead.

Senator HUTCHISON. Well, let me just say that I certainly understand that you don't want to take any money away from the future by having that continuation on the certification. However, we also have to look down the road at all of the things that happen that we don't expect to happen, and I want to make sure that we don't have a gap that really is unacceptable from a scientific standpoint. So let's work on something that doesn't take away from the CEV or our long-term goal, but also recognizes that, in the next decade, a lot of things could happen——

Mr. O'KEEFE. Sure.

Senator HUTCHISON.—from a hurricane to some other delaying—something doesn't—a part doesn't come in or doesn't fit or you don't have the progress you think you're going to have.

Mr. O'KEEFE. Yes, you bet, absolutely, and I couldn't agree more, Senator, and we will work with you.

The one issue I would caution—and I'd invite General Stafford to comment on this, as well—is, you know, the issue of certification is something I really want to steer off of as a general proposition, because it implies that somehow we have eliminated all of the risks that would be involved in something. We're never going to do that. This is always going to be a risky proposition. We will never eliminate that.

And what we're doing right that is short of that term is, again, tearing down every single one of the three orbiters to assure that we've done this in a very, very extensive, major-modification effort to bring it up to an industrial standard we think gives us the best shot at flying those vehicles for the balance of time that it has available to complete the International Space Station, to do what we've committed to do, to yield the science return that we'd always hoped for. And I think we're within range of that.

Just on the efforts we see today on Expedition 9, the returns we're getting off the science is really compelling. And so the opportunities to do that, I think, are ahead of us and in order to do this within the achievable is what our objective is, and to do it in a way that guarantees we do it to the best of our ability.

Senator HUTCHISON. Before my time is up, because I understand that issue, but the last thing I wanted to bring up is the issue of Russia, which also ties into this. They've—apparently, their patience is wearing thin on borrowing their Shuttles. So what is the situation with Russia? Are we going to have something with them that would be ongoing after 2006 when the contract is up? And is it going to be something that helps us get through this period and then we will be able to carry our load again?

Mr. O'KEEFE. Uh-huh, no, thank you, Senator. The Russian performance as a member of the International Space Station partnership has been exemplary. I mean, they have done an amazing job. And they are as professional and as focused to the task, to accomplishing these efforts, as we ever could have imagined. Any doubts about that have been absolutely eliminated. They have done a fantastic job.

We are in the middle of negotiation now with the completion of what's referred to as the Balance Agreements, which is for the remainder of the time between now and Fiscal Year 2006. We're also laying the groundwork in that baseline for the agreements that would follow after that, in terms of continuing, kind of, efforts as all of us as partners to support the International Space Station. That's continuing well. And along the way, there has been no diminution whatsoever in their support. Absolutely. All of us have got challenges that we're wrestling with, and they do as well as our other partners do. But they have not diminished in any way.

Last Monday, the Expedition 10 crew was announced. That's due for launch in October. And our Expedition 9 crew will be returning. I plan to be there to assure that that gets observed, and we continue to work with our partners to accomplish this.

But there is nothing but the highest professionalism I've seen there. The new Director General of the Russian Space Agency, Anatoly Perminov, has really done an astounding job of getting started right away, and into the saddle immediately, and we haven't missed a beat with the partnership. So they've done an exemplary job, and we continue—we expect that there will be a continuation of that performance.

Senator BROWNBACK. Senator Breaux?

STATEMENT OF HON. JOHN B. BREAUX, U.S. SENATOR FROM LOUISIANA

Senator BREAUX. Thank you. Thank you for your presentations.

I'd like to just touch on, I think, what Senator Lott might have been referring to, and others, in the sense that it seems to me that we've got two challenges, among others; and one is to pay for the past, and also prepare to pay for the future. The past being: How do we fix the existing Shuttle? How do we make sure the Space Station is working? And, at the same time, with a limited amount of money, embark on new missions to Mars and new missions to the Moon, and a new vehicle. And it seems like we've postponed

fixing the past to pay for the future; at the same time we're short-changing the future because of the costs of the past. Now, I don't think this all adds up. I mean, we've still got problems in the past and that you're being challenged to go out with new launch vehicles and new missions to Mars and to the Moon, and there's no extra money being requested for all of this. It just doesn't add up, from where I sit, that you're not going to be able to—while we're losing tiles in Cape Canaveral, well, we're also still losing tiles on the Shuttle. And that ain't fixed. I mean, you can't do it with the money you've got. Now, you tell me how you can.

Mr. O'KEEFE. Well, sir, I think the budget request the President made in February of this year covers the costs we believe are necessary in order to return the Space Shuttle to flight. We've got additional costs that we've identified as part of this latest implementation plan. We can handle that. This is not a show-stopper by any means. There are methods and different options we're looking at now to accomplish that.

But the first major step is, the Congress would support the President's budget request. We are on our way. There is every indication that that may be problematic. The House Appropriations position a month ago—2 months—I'm sorry, a month and a half ago—would significantly diminish that capacity. It would make what you just said an absolute fact: We can't do this at the levels that they have contemplated. So, as a consequence, this really is, in concert with the *Columbia* Accident Investigation Board's report, in which they said the President has to establish a vision, has to establish a strategy, has to ask for the money necessary. Well, we did those three things. The next step that the Accident Investigation Board argued is that Congress has to support that. We're looking for that last step. And we appreciate your indulgence in getting there, but that's going to be the major effort in order to achieve this.

At that point, we're talking about at the margin. Under the present conditions, if the House Appropriations position goes forward, you're right, we cannot do this.

Senator BREAUX. If the amount that the House has appropriated is the final amount appropriated to the agency, what would you have to slow down, cut back, or eliminate?

Mr. O'KEEFE. Whoo, boy. I think it significantly compromises the opportunity for the exploration agenda. The Crew Exploration Vehicle is something that—you know, the whole Constellation effort gets put in abeyance. The effort that we've really labored in the last couple of years to see a breakthrough in in-space propulsion, through Project Prometheus, is something I don't see any option, in terms of proceeding with that. Our first primary objective is going to be to get the Space Shuttle back flying to complete the International Space Station. That's agenda item number one. And Return to Flight, anything else beyond that, that's what we've got to focus on in order to achieve any of this under any combination of events. So it makes all those other efforts very, very much compromised.

Senator BREAUX. Well, I mean, I think, Mr. Chairman and our colleagues, I mean, that really is the question. We can outline some very ambitious concepts about what we need to be doing—fixing the Shuttle, fixing the Space Station, going back to the Moon, and

then ultimately to Mars—but if we don't fund it, we can't do it. And we have a disconnect here between what we're giving them as a mission to do, which is very laudatory in public pronouncements, but if we don't support it, it's not going to be able to get done. I think you've heard the Administrator say that there would have to be substantial changes in all of these missions if we don't do any more with the funding than what the House has contemplated. I mean, you just can't——

Mr. O'KEEFE. Yes, sir.

Senator BREAUX.—you can't accomplish it with the tools that we're giving you, in terms of appropriations. And we're going to have a make a decision. What are our priorities? Is this one? And if it is, we're going to have to step up to the plate with the necessary funding to do it or we're going to have to drastically change the mission.

So thank you all for the good job you're doing.

Mr. O'KEEFE. Well, thank you, Senator. I appreciate the illumination on the issue, because it really is that imperative. And, again, if the House position prevails, the clear position from the Administration that's been articulated is the President's senior advisors will recommend that he veto the bill, period.

Senator BROWNBACK. Mr. Administrator, I feel like now we're getting somewhere, OK, on the discussion. Because this is—what I've looked at, as well, for some period of time, and have been very strongly supportive of the President's exploration vision. I think that it's time, on the manned space programs, for us to really look beyond where we are right now. I think on the unmanned programs, you guys are doing a fabulous job. It seems like good vision, well established, it's being accomplished, things are moving very well. So you, kind of, set that portfolio aside and say, "Great job," from a policy point of view.

The policy point of view on the manned space program, though, you look at that, and you—I think we're stuck too much paying for the legacy of the past and not projecting on into the future here. I mentioned, at the outset here, about looking at the Shuttle. One outside group has said, "Do we need 30 more missions with the Shuttle?" Now, this is over the life expectancy of the Shuttle; that's not this next budget year, which you're focused on, and I understand that. But if you look at what they are saying, they're saying you can do this in 10 to 15 flights, not 30, if you offload a series of things. I know you've been looking at this internally, as well.

Looking on down the road, isn't it time we had that type of policy discussion of saying that the legacy cost of this is just too much, we have some other options, and we really need these funds to go into the next phase for human spaceflight, and try to really have that level of policy discussion, if we're going to whittle these down to half the number, so that we can get that money flowing toward the exploration vision the President articulated in the middle of January?

Mr. O'KEEFE. Yes, sir. I take your point. And please be assured that the approach that we've used in trying to come up with what is the longer-term objective and completion of International Space Station has been driven by the general mantra of: every single flight has to fight its way into the manifest, has to justify the rea-

son why we're going to fly it. And what it really comes down to is, we've done a terrific job over the years of designing every one of these components and modules to fit precisely into the Space Shuttle cargo bay. It is "the" asset that gets it all there. It's lined up impressively. It's one of the facilities that rode out this hurricane with great skill—is all those modules are lined up perfectly and going through testing——

Senator BROWNBACK. I understand. We——

Mr. O'KEEFE.—at the Kennedy Space Center. That's the only way to get them there.

Senator BROWNBACK. Yet the Planetary Society and, as I understand it, some of the internal discussions are saying you could offload a number of these missions and get it down to 10 to 15.

Mr. O'KEEFE. Tactical——

Senator BROWNBACK. Have you looked at either their studies or at your own internal ones that would say we could cut the number of Shuttle missions in half?

Mr. O'KEEFE. With all due respect to the Planetary Society, we are desperately trying to accomplish the task of getting the modules we know are there through the means that is feasible to do, that's known. And anything we can offload, in terms of logistics requirements, whatever else, we are actively exploring those alternatives now to see what kind of commercial servicing options may be pursued. We will put out a request for information on that. The industry is out examining that now. But I don't see a real significant diminution of the flight rate, because it's just the sheer volume of hardware that fits exactly within the Shuttle, and there are no other means, lift, in order to accomplish that task that we know of.

We'll continue to look at that, constantly. This is an ever-moving effort. And our friends in the International Space Station partnership, their only interest is—not, how does it get there—that it does get there. They are agnostic to the question of exactly how it's accomplished. And so the means by which we achieve that goal is the objective, and we're constantly looking for new ways to do that.

Senator BROWNBACK. We will continue that discussion.

General Stafford, I want to ask you something on heavy-lift capacity, because this is something else that we've wrestled with here for some period of time. And I don't mean to put another issue on the agenda, but, as we do budget these things on out, you chaired a study—gosh, that's over a decade ago—and thank you for your continuous service to this government and your repository of knowledge that you continue to provide to us. But you said then that we were—experience has shown that large liquid hydrogen and oxygen engines have been expensive to develop and operate. Oxygen and hydrogen propellant is not an attractive option for the first stage of heavy-lift launch vehicle because of the large tank volume and safety concerns of using hydrogen below an altitude of 100,000 feet. I don't mean to drag you back to a decade-old report.

General STAFFORD. Oh, I sponsored——

Senator BROWNBACK. You probably know this well, but aren't we at a stage now where we really need to be focusing on different or better options for heavy-lift capacity, as well, as we look forward into the future?

General STAFFORD. Well, we were looking at the time-set that I chaired the Synthesis Group, sir, to look forward. And one of the key efforts for exploration is large mass to low-Earth orbit. And from that, it takes a heavy lift. And we were looking at the lessons learned from Apollo. We were looking at lessons—had inputs from academia, from industry, all over. And, at the time, they said for the first stage for volumetric efficiency, was probably still the locks or something like that, with kerosene. And the upper stages would certainly be a very high efficiency, with hydrogen and oxygen. Now, things have progressed since then. You can use booster stages on the side. But the main criteria is a large mass to low-Earth orbit, Mr. Chairman.

Senator BROWNBACK. And have we accomplished that? Are we getting the heavy-lift capacity now that we need?

General STAFFORD. Well, the only heavy-lift capacity that exists in the United States today is the elements from the Space Shuttle. And if—there have been, you know, certain ideas put forth, like the Shuttle C, at one time—that was back in the 1990s—and that would put about 140,000 to 170,000 pounds, if I'm correct, into low-Earth orbit. The Saturn V, at the peak, put about 300,000 pounds when the third stage shut off; and then to escape velocity, it was approximately 120,000 pounds.

Senator BROWNBACK. I'm concerned we've not addressed this adequately. And this is a big, big issue, as well——

General STAFFORD. Yes, sir. I'm——

Senator BROWNBACK.—exploration. And this is one, as an issue, that's been around for some period of time.

General STAFFORD. That is correct, Mr. Chairman. And I agree, we have to have a heavy lift for a large mass to low-Earth orbit.

Senator BROWNBACK. Senator Nelson?

Senator NELSON. Which brings us back to the policy question, Mr. Chairman, that Senator Hutchison had raised. If your only capability of heavy lift is what we have now, and if we know that history tells us, in the development of new technologies, that it doesn't come in on time, so that the Crew Exploration Vehicle likely would be delayed, instead of there being a hiatus of 4 years under the present plan of the policy, as articulated, which—you stop the Shuttle in 2010 and the CEV isn't ready until 2014, with the slips that are likely, you're talking about 5, 6, 7 years that we would not have a man-rated capability of getting up.

Senator Hutchison said that in her own words. I'm saying that in my own words. And I think that that is a dangerous position for the United States to be in, that we would be down, without the capability of launching humans, over a 5-, 6-, 7-year period. Would you comment on that, Mr. Administrator?

Mr. O'KEEFE. Well, again, I think there are two mitigating factors here, Senator. And I don't disagree with your assessment of what could be the worst-case scenario. That said, we're going to know this sooner than later.

I mean, the approach that the exploration systems folks have come up with on these broad agency announcements is to look at the first spiral, first increment necessary, for an unmanned, admittedly, piece of Project Constellation. And that's due for 2008. That's what everybody's targeting on, that's what everybody's focused to.

And exactly how that will evolve beyond 2008 is a point that we'll know a whole lot better long before that first flight occurs. That's before the retirement of the Space Shuttle program. And so, as a consequence, you're going to see some overlap here, and we're going to make some, you know, much better judgments as we get closer to the event, rather than speculating on what could be, best-case/worst-scenario.

And we've often been accused at NASA of being way too optimistic. This is one where we've covered all the imperatives here, where you're going to see a demonstrated capacity of that first spiral before there's ever an intent to complete the Shuttle program. And we'll see what the determination is that time. But everything's tracking exactly right, and the enthusiasm out there for meeting this objective is great.

The last point that I'd raise is, one of the things that we can't understate or diminish is the extraordinary learning we've gotten from the International Space Station assembly process. This is an engineering marvel. I mean, we've learned how to assemble pieces on orbit in a way that, frankly, 10, 15 years ago, the debate was, "Can't be done. Can't be done." Great confidence exerted by lots of folks who knew what they were talking about, obviously, who said, "Cannot be done." Well, we've got a couple of folks living there right now in this can't-be-done machine, and it's half done.

We are tracking right now. Every component is in line at the Kennedy Space Center now, ready for launch as soon as we can get back to flying. And that's an accomplishment that, really, we've learned an awful lot about how to do on-orbit assembly that, frankly, 10, 12 years ago, was viewed as impossible.

So all that considered, rather than be wildly optimistic or be forecasting wildly pessimistic, what we're going to see is a series of events and dates coming up here toward the end of this decade in which we're either going to meet that first spiral, or we don't, and the proof will be in that particular demonstrated event. And if it is, we're going to make some determination of where we go. There's time.

Senator NELSON. Mr. Administrator, what you need is Congressional oversight, and that is something that has been sorely lacking here. With Congress not being able to pass an authorization bill for NASA—you've heard that in other arenas, such as intelligence activities, which is one of the things that we're dealing with right now in Congressional oversight—and the Congressional oversight that I'm giving you, as expressed by a Republican and a Democrat in a nonpartisan space program, is that it's not in the interest of the United States that you have a 5- to 7-year hiatus in which the United States does not have the capability of launching humans. And that's what I would purely offer to you.

General Stafford, you're known for your straight talk. I want to ask you three questions. Has your Task Group witnessed any barriers or impediments or areas of concern for Shuttle safety that were not previously addressed by the CAIB?

General STAFFORD. Senator Nelson, at this time, to my knowledge, we have not, you know, identified any barriers—or not—and I'll check with my three panel leads back here.

Senator NELSON. OK, second question. Have you witnessed, General, any Return to Flight launch-schedule pressures affecting NASA's decisionmaking?

General STAFFORD. In my observation, Senator Nelson, no. As I pointed out to the Chairman and the rest of the Committee, what we observed are milestones, that NASA will achieve a milestone before we go ahead and close out those items.

Senator NELSON. The third question is, what is your assessment of the workforce morale and the skill levels to meet the Return to Flight goals?

General STAFFORD. Well, as I pointed out in my statement, Senator Nelson, the Return to Flight Task Group is concerned about the personnel to support the whole effort, and this was written up in our last report—you know, the quality of people—because we're expanding the safety organizations, and all this is coming out of other NASA personnel and the contractor pool that is available.

As far as the morale, now, again, my three panel leads have had daily interface with those people, and I'll look to them to check on—as far as morale.

All of them have said basically the morale is high in their daily meetings. And from what I've observed—and, again, in a macro sense, sir—it's high.

Senator NELSON. Thank you, General.

General STAFFORD. One thing—I would like to respond again to the Chairman about the heavy lift that just came to mind. Again, when we completed that study, Mr. Chairman, 13 years ago, we outlined, you know, the heavy-lift capability. But, again, technology has progressed in these 13 years, so 160,000 pounds to low–Earth orbit today will do more than what it did back when I conducted that study, sir.

Senator BROWNBACK. Good. I just—I pointed it out because you did that for Moon-Mars mission review at that time, and talked about the need for heavy-lift capacity to be——

General STAFFORD. Right.

Senator BROWNBACK.—able to do that. Now, maybe it's a different ball game now, and hopefully it is. It's just as an issue—as I look—saying, OK, we want to get to this new vision for manned space exploration—I want us to invest our dollars there, and it seems like we've depreciated out the old machinery here, and it's time to move on forward. It's got a heavy expense in repair if we're going to use it, and, you know, we're at $2.2 billion on Return to Flight now. We don't know if that's the exact number it's going to finish with. You've got 5 of 15 items accomplished, but you've got ten more to do. We don't—we've got to either have a system where you can repair, in-flight, or rescue. That seems like, to me, you're going to—you're talking about some serious dollars being able to do either of those types—or probably you'll want a system where you can do both of those if we're going to use the Shuttle. And I just—I'm looking at this thing, and this thing has got a lot of cost associated——

Mr. O'KEEFE. Well, Mr. Chairman, if I could, the one point I would caution is that this is not an additive or exponential equation here, where you take five recommendations and it costs this

much to get there, and another ten to go, and so you take the exponent and you just escalate it. This is basically what the cost is.

Last summer, when we, you know, estimated the cost of what we were doing here, we were really, you know, doing a forecast that was well within a swag, because the Accident Investigation Board recommendations were just codified on August 26th of last year. We formulated our best bet in putting this together for part of the budget. And what we've now encountered is a whole series of things that we've done that I think, in the end, is not so much an increase in cost as much as it's just a front-loading of cost. What we're doing—again, all three orbiters in major modification. That would normally happen over a span of 5 or 6 years. The fact that it's intensively happening all in a span of about 18 months is what's front-loading these costs. It means you save cost from the out-years of not having to do that.

The second thing we're doing is a lot of sustaining engineering effort. One of the observations in the recommendation in the Accident Investigation Board report was the requirement for inspections and a whole range of different, kind of, capabilities, organically, within the agency, to do this. That's going to cost, over time, organizationally, the effort necessary, and that's what I think Tom Stafford has observed, is that we're really tapping some of the best folks out there, but that's kind of getting to be a diminished number, because we're recruiting them all in to be part of the Engineering and Safety Center, to be part of the Independent Technical Authority, to be part of the sustaining engineering effort at Johnson, at Marshall, at Kennedy, in order to assure we've got a robust engineering capacity in those places. That's going to cost, and it's going to be cost over time, in terms of those organizational changes. And it isn't directly related exclusively to Shuttle itself.

So part of this is an adjustment of cost up front, rather than an increase or an additive cost over time. And, indeed, we'd much rather see that happen now, during this time when all the orbiters are down, so we can do the kind of repairs necessary to make the upgrades necessary for sensors and the booms and everything else, to do that right.

Senator BROWNBACK. And that's agreed. It's just—I don't think we know that the $2.2 billion is a hard figure, either. I mean, it ought to be, and it looks like, to me, it's probably more than a swag off of this one, but, still, you just don't know what these things are going to consume, budgetarily, on you. I mean, I hope this is the end of it for—as far as, OK, yes, we can do it, and we're not driven by dollars or time-frames; we're driven by milestones so that nothing happens until this thing is certified that we're——

Mr. O'KEEFE. Sure.

Senator BROWNBACK.—we're clear and we're good to go on it. But, you know, that's——

Mr. O'KEEFE. Well, for what it's worth, I mean, you're absolutely right. I don't want to mislead you in any way that we've got a firm, fixed handle on these numbers. No doubt about, this is always going to be something that's going to come up here. I mean, it seems like it's a daily event, you know, between acts of God and everything else that occurs.

That said, the number we're looking at today, the cost we're looking at, the efforts we're engaged in, what we're doing to, you know, kind of work through each of these recommendations by the end of this year, is a whole lot better understood than where it was on this very date one year ago. And at that time, it was, you know, a forecast, at best. Today, we can bind this within a parameter.

General STAFFORD. Mr. Chairman, say we have conditionally closed out 5 of the 15 recommendations. We're also way down the road on many of the other 10, Mr. Chairman. And hopefully, in the next 2 to 3 months we can close out another 4 or 5. Our planning factor is the end of December, but we're not going to stop until everyone has, you know, met those milestones. But we're way down the road on considerably more than just those 5 that have been conditionally closed, Mr. Chairman.

Senator BROWNBACK. So you believe, as you independently review this, by somewhere near the end of this year, that you should be able to close out all 15?

General STAFFORD. If the conditions are met by NASA. That is our planning factor. If they're not, we'll go right on over into the next year.

Senator BROWNBACK. No, I understand the planning factor. But I'm just saying, as you observe, from outside NASA——

General STAFFORD. Yes, sir.

Senator BROWNBACK.—and what it is doing, you believe they are on track to hit all 15 milestones by the end of this year?

General STAFFORD. It may be difficult on several of them, sir. And particularly, as I outlined, the biggest challenge is the external tank and the outlining on the critical debris. So the technical part is really the critical part, and Mr. Cuzzupoli could enlighten me if there are any further sub-details that you would need.

Senator BROWNBACK. But you believe the technical ability is there, even on the external tanks, to be able to accomplish this limitation of debris?

General STAFFORD. We know that a lot of the areas have been accomplished. And right now, the milestone looks like that they should ship the tank there in November. But, again, they won't ship the tank until the criteria have been closed.

Senator BROWNBACK. Mr. Cuzzupoli, do you want to comment on this? Do you mind? I hate to extend this, but this really goes to the core of what we're trying to get at, at the hearing.

Mr. CUZZUPOLI. Thank you, Senator.

Senator BROWNBACK. Are we going to be able to technologically address the issues on the external tank?

Mr. CUZZUPOLI. Yes, we will. And from an independent viewpoint, NASA has done one great job of identifying their fixes on the external tank, and they've got a real good path to getting there. The issue, again, is to make sure that none of the foam comes off the critical debris area, and that's a tough job.

The CAIB has put some very strong recommendations, very high recommendations. And NASA, again, has lifted the bar over that recommendation, and it's going to be a difficult work going forward, but I believe what the General said, that—by the end of the year—right now, the recommendations look like we can maybe conditionally close all of them. Some of them will have to stay open

based on verification. But they're on the—on a milestone schedule, to complete everything by the end of the year, as far as recommendations.

Senator BROWNBACK. So no technological hurdle that's insurmountable on the foam issue and the external tank.

Mr. CUZZUPOLI. We, on the independent parties, have seen none that can stop them from going forward.

Senator BROWNBACK. And you, as an external reviewer, believe that they are on track to be able to close this out, at least conditionally, by the end of this year.

Mr. CUZZUPOLI. Yes, Senator.

Senator BROWNBACK. OK, good.

All right. Gentlemen, thank you. Thank you very much.

Mr. Administrator, I might add—throw one final thought in. As we're putting the appropriations together for this year, it seems like we really—it may be time, given the Administration's view on this and a veto threat—or recommendation of a veto by key advisors to the President, more accurately—you know, it may be time to try to get some of the chief sponsors of this together to try to discuss that—while we may talk about an out-year issue, you've got a near-term, this-year issue that we need to resolve. We've got budget caps. We're trying to get back into a balanced budget. Everybody understands that; you more than anybody, having worked in this process before, and you understand where you are in the appropriations process. But it might be wise to try to get some of the key, chief people together in the House, Senate, and the Administration to try to resolve this issue here pretty near-term so we could maybe come up with a number that not anybody is completely satisfied with, but that's workable on this year, and on a this-year appropriation. And it seems like it may be a wise thing to do here pretty near-term.

Mr. O'KEEFE. No, I appreciate that, Senator. And this is certainly a clear understanding on our part, how challenging this is. This is a really tough budget year. There's no doubt about that.

That said, I think you put your finger right to it. A lot of the debate and discussion about what we do in the out-years and what's the right permutation and when's the gap and—that's academic if we can't get through this first stage. And we understand that to be two critical factors. The first one is, we have to demonstrate a proficiency—technical and professional proficiency—of Return to Flight. That's our fundamental objective right now to do that. And number two is—and equally important—is, the Congress of the United States, if it would simply support what the President's budget request has done, that will get us toward that objective.

So how we debate what these out-year permutations are, are really important, they're significant, they're imperative for accomplishing this strategy, but we can't even get out of the starting gate unless we can accomplish this, in this coming year, on those two variables. And that's where, you know, the issue resides right now.

Mr. Chairman, if you would permit me one last point.

Senator BROWNBACK. Let me finish this thought, though——

Mr. O'KEEFE. Yes, sir.

Senator BROWNBACK.—because what it seems like I'm observing is that you've got a pretty strong group supporting the Space Shut-

tle, you've got a strong group supporting the exploration mission, and then you've got a strong group that doesn't want to concentrate resources in fewer areas, which you're going to need to do to be able to get these done. And what I would hope we could do is, in the near term, the first year, let's try to agree on a number, that we can hit those as we continue to negotiate that set of three policy issues that are out in front of you, which I think is all doable, but you are going to—it is going to have to take somebody kind of pulling the pot together and getting it made so we can get that done.

Mr. O'KEEFE. Fair enough. I agree with you wholeheartedly.

If you'd permit me one last comment, sir.

Senator BROWNBACK. Please.

Mr. O'KEEFE. There was—at the point in which there were a couple of discussions of what the morale and what the condition of it is across the agency, let me just offer, rather, my opinion—as anecdotal evidence, I admit—a missive that was sent out a couple of weeks ago by the deputy program manager of the Space Shuttle program, Wayne Hale, that he sent around to all the Shuttle team members and all the colleagues we have that are working this issue. It really is uplifting. It is a piece that speaks more, in my judgment, to what the morale of the people who really matter, that are really turning the crank and doing this job and are dedicated to this task, have summarized. And this is something I consult just about every day now, because it is an important reminder of what this is all about and why people care about it. It's a really great piece. And if you'd permit me, sir, to insert that for the record, I'd appreciate it very much.

Senator BROWNBACK. It'll be in the record, without objection.

[The information referred to follows:]

Subject: Back to School (August 25, 2004) by Wayne Hale, Jr., Deputy Program Manager, Space Shuttle Program

The new year doesn't start on January first; it really begins when school opens.

The whole family has to get back into the familiar routine, up in the morning, breakfast, school bus, homework at night, school activities. There is electricity in the air with the excitement of new opportunities. No matter how busy the summer has been, the rhythm of life speeds to new heights with the start of school. And even though we have our calendars marked in advance, the start of the school year always seems to come as a surprise.

For the Space Shuttle Program, it's back to school time, too.

Almost unexpectedly, we are back into routine: flight design is into the production template, the crew training is on schedule, and all of those old standard preparation work items are on the agenda. Stacking has started on the flight boosters. *Discovery* is powered up, the schedule says "up mission processing." There is a full court press underway in the OPF for both *Discovery* and *Atlantis*; parts are no longer being removed, but installed and checked out for flight. Flex hose and wiring inspections—while never finished—are no longer the focus of our attention nor are they the pacing items. At Michoud, foam is going back onto ET–120 for flight—certified!—after a long period of removals, dissections, tests, and discussion. Everywhere we look; we see flight preparation routine at last. Even hurricane season seems to be part of the routine and will not slow us down.

A promotion in grade school leads to more difficult courses. Long division is tough but the answers are more precise than short division. Algebra is not just a harder form of arithmetic, it requires a whole new way of thinking. The homework takes longer than it did the previous year. So it is with the Shuttle program. We also have a new way of thinking and a new standard of precision to meet. Problems require more work, more analysis, more tests than they did "last year." Our homework is going to be tougher, and take longer. But the answers will be worth it: we will know rather than guess, hope, or ignore, and we will fly more safely.

When I was in college, after just the first day of classes I always felt I was 3 weeks behind on reading and homework assignments. So now with the Space Shuttle program; a huge amount of work is ahead. Even though the challenge seems formidable, we know that somehow we will get it all done.

The juggernaut of testing, analysis, review, and certification must be completed, even while working through the template to flight. Yes, this year is going to be tougher than before.

At the end of the spring semester there is always a big final exam that tests everything covered during the year. Even before the first day of class every student knows that the final exam will come. It is the same with us; next spring we will have a big Final Exam that will test everything we are doing. Every decision will play into that test grade. Every test, analysis, redesign, certification, and installation will be tested. Our final exam will be pass/fail. As surely as if we were in school we must make the full use of every day to make sure we pass.

But just as the new school year brings the bright promise of new beginnings and excitement, there is a new excitement is in our lives even as the pace of work grows faster. The new beginning for us is irrevocably tied up in the "new culture" of NASA. This "new culture" is really the old original NASA culture. Our cultural change is to go back to the basics. Solid engineering must back up technical and management decisionmaking. No risk decisions based on the hopeful optimism of press releases or the forced ignorance of cost constraints. Rather, solid decisions made on the basis of hard facts proven by test and thorough analysis. Every one of us must summon up the courage to deliver the information that—perhaps alone—we know. We must have the integrity to deliver the facts whether or not they will be received well or with disappointment. From this point on, we will look each problem in the face and we will solve each one the old fashioned way: by hard work. That is what made our predecessors in this agency successful; that is the lesson that ensures our success; that is the lesson that we have had to relearn at a bitter price.

Some ask, "can we afford to deal with problems in the new (old) way?" Wrong question. Rather ask, "can we afford to deal with problems as we did before?" No, good as that process was, fast as it was, there was too much slipping through the cracks, leaving too many opportunities for Murphy to deal us a losing hand. Precision and thoroughness have always been required in space flight. Our Apollo predecessors knew that. Now, we must take dedication, thoroughness, and hard work to a new level, reach deeper, pull harder.

Most school teams have their cheerleaders to encourage them. The whole nation is pulling for us. Every chance encounter with the public confirms that the virtually everyone in our country wants us to succeed, wants us to fly again. The International Space Station team is counting on us, holding the fort day by day until we arrive. It cannot be possible that we could let them all down.

We have the best and the brightest on our team. If this team is not dedicated enough to our goal of safe and successful human space flight, I don't know who ever was. If this highly trained, well educated, and thoroughly experienced team is not sufficient to make Shuttle flights safe, who is? If this agency cannot fly in space, who from our Nation in our generation will be able to? We made a promise that we would carry the torch on, that we would never make the mistake of overconfidence again. This year, I am confident we will pass with flying colors.

School is now in session.

Mr. O'KEEFE. Thank you, Mr. Chairman, you're very kind. Appreciate that.

Senator BROWNBACK. Gentlemen, thank you all very much. And I want to congratulate you, Administrator O'Keefe, General Stafford, really for the work that you guys are doing. And while the questions may be, you know, back and forth and seem pretty aggressive at times, it's our role to try to do some oversight where we try to dig into the issues of the day, and we're wrestling with a big set of policy issues, as you are, and we want to review your policy decisions.

Mr. O'KEEFE. We'd be disappointed otherwise, Mr. Chairman.

Senator BROWNBACK. Well, we wouldn't want to disappoint you. But I don't want that thought to diminish the thought, as well, that we really want to commend you for the work that you're doing——

Mr. O'KEEFE. Appreciate that.

Senator BROWNBACK.—because I see a lot of very positive things that are very uplifting for the country. And there are going to be struggles, and this is a cutting-edge area that you're in, and so there are just—there are going to be difficulties with that. And sometimes it's hard to explain to the American public, too, when they'd rather have the pothole fixed in the street, that, you know, this is important. It is important, and we need to be always out there talking about that, but we also need to make sure that the policy directions are one that the vast majority of the United States public supports. It's not a partisan issue. It doesn't cross—it doesn't cut Republican or Democrat. This is about Americans leading on forward, and I think you're both doing a very commendable work in that, and I want to thank you for doing that.

Thank you all for coming. The hearing's adjourned.

[Whereupon, at 11:34 a.m., the hearing was adjourned.]

APPENDIX

PREPARED STATEMENT OF HON. JOHN MCCAIN, U.S. SENATOR FROM ARIZONA

Good morning. Just over 1 year ago, NASA's Administrator Sean O'Keefe was joined by Admiral Harold Gehman in testifying before this Committee about the *Columbia* Accident Investigation Board (CAIB)'s findings into the causes of the tragic Space Shuttle *Columbia* accident. Today, we welcome back Administrator O'Keefe to update us on the progress NASA is making to implement the CAIB's recommendations and return the Space Shuttle program to flight. In addition, we welcome Lt. General Thomas Stafford, a distinguished Naval Academy graduate and astronaut, to discuss the Return to Flight Task Group's role in providing an independent assessment of the agency's actions in implementing the CAIB recommendations.

The CAIB report was one of the most comprehensive accident investigation reports in U.S. history. The report laid out a number of hard decisions that both NASA and the Nation would have to make to ensure a safe Shuttle program. I congratulate Administrator O'Keefe for embracing these recommendations, and working to implement them. As we examine NASA's activities, we must acknowledge that the return to flight of the Space Shuttle is the first goal of the President's ambitious new initiative to return Americans to the Moon and explore Mars.

As we will hear today, NASA still has a lot of work to do before the Shuttle can fly again. So far, only five of the CAIB's 15 "Return to Flight" recommendations have been conditionally approved by the Return to Flight Task Group. This Committee remains extremely interested in NASA's efforts to implement the remaining 10 recommendations, especially the status of the in-flight emergency repair of the Reinforced Carbon-Carbon panels on the leading edge of the Shuttle wings, and the program to eliminate the shedding of debris from the External Tank.

I hope that Administrator O'Keefe and General Stafford also will address the status of in-flight tile repair; the establishment of a truly independent Technical Engineering Authority; NASA's plans to use the International Space Station as a "safe harbor" in case the Space Shuttle is damaged; and the recent damage caused by Hurricane Frances at the Kennedy Space Center. As the Administrator knows. I have included statutory language in S. 2541, my legislation to reauthorize NASA, to ensure that the CAIB's recommendations are implemented.

One issue of great concern to me is that NASA's old problems regarding cost overruns have reappeared. According to briefings that NASA has given the Committee, NASA expects $114 million in cost overruns for Shuttle operations and sustaining engineering activities in Fiscal Year 2004, and $357 million for Fiscal Year 2005. I look forward to hearing Administrator O'Keefe's explanation for these overruns, and what programs NASA may cut to pay for them. In addition, I look forward to hearing his explanation of an additional $405 million in projected cost overruns in FY 2005 for Return to Flight activities. I also hope that he will inform the Committee at this hearing if NASA intends to submit a revised budget request for FY 2005, and describe to us what it will look like. If NASA wants to reform its credibility and build support for the President's new space exploration initiative, it will have to get its budgeting house in order.

Space travel is inherently risky, and we will never be able to make it 100 percent safe. However, we should work to enact the recommendations of the CAIB to ensure that the problems that caused the *Columbia* accident do not return. I commend both Administrator O'Keefe and General Stafford for their efforts, and look forward to hearing their testimony.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN MCCAIN TO HON. SEAN O'KEEFE

Question 1. Will the damage to the Kennedy Space Center due to Hurricane Frances cause further delay in returning the Space Shuttle to flight?

Answer. It is too early to make an accurate assessment. The combined effects of the three hurricanes, Charley, Frances, and Ivan, will be determined over the next several weeks. It is known that our Shuttle Processing workforce has lost many days of productive activity due to the safe closure of the Kennedy Space Center (KSC) in response to the hurricanes. The impact to orbiter processing milestones and any other impacts will be assessed and presented to the Space Flight Leadership Council. The results of NASA's assessment and decisions on Return to Flight will be shared with the Congress when the results are available. Like all milestones toward Return to Flight, if the milestone cannot be met, NASA will slip the launch to the next available launch window and adjust milestone completion dates accordingly.

Question 2. In a July 30, 2004 letter to me, NASA indicated that in addition to the "Return to Flight" costs there are increases of $100 million and $300 million for FY 2004 and FY 2005, respectively, for the Shuttle program for program operations and sustaining engineering. In briefing material presented to the Committee in July, it was indicated that most of these increases are influenced by *Columbia* Accident Investigation Board recommendations and that the actual amounts were $114 million and $357 million for FY 2004 and FY 2005, respectively. Can you elaborate on these program operations and sustaining engineering cost increases and how NASA plans to address them?

Answer. As a result of the *Columbia* experience, flight hardware is now subjected to greater levels of test, analysis, performance monitoring, inspection, repair, and recertification for flight. The program's safety controls are being reassessed, as are its industrial processes, to ensure nothing is overlooked that might lead to a safety of flight issue later on. In the short term, this has led to more intensive investigations into flight hardware anomalies not related to Return to Flight (RTF), such as the flow liner and flex hoses. In the long term, additional resources will be required to sustain the levels of analysis, investigation, and integrated risk assessment that were found lacking by the *Columbia* Accident Investigation Board (CAIB), but not addressed specifically in every Space Shuttle project. NASA will continue to evaluate the effectiveness of these changes to ensure that only what is absolutely needed for safe flight is retained for the remainder of the Shuttle's service life. As promised, revised estimates for both RTF and Shuttle operations and sustaining activities will be provided in the fall. However, the full impact of RTF on Shuttle costs will not be known until after the first few Shuttle missions are completed. The $114 million increase for program operations and sustaining engineering will be addressed within the Space Operations budget. More detail will be provided in the next Operating Plan update. NASA will continue to assess requirements and identify strategies to incrementally address the FY 2005 shortfalls. NASA may have to reallocate funds from lower priority activities, corporate accounts, or other program reserves.

Question 3. Why is it necessary to identify these costs as separate from "Return to Flight" costs?

Answer. It is essential to separate RTF costs from operations and sustaining costs for three reasons. First, is to ensure that there is no duplication of effort leading to unnecessary expenditures. Second, NASA made a commitment to separately track the RTF costs so that they might be accurately assessed and budgeted. Third, the technical basis for the increases in operations and sustaining activities, while they may be in part a result of the *Columbia* experience, may also be influenced by other factors that must be assessed for their long-term contribution to Shuttle safety and performance.

Question 4. Why did NASA not address these cost increases in their written statement or oral remarks during the hearing?

Answer. Administrator O'Keefe's written statement and oral remarks to the Committee were focused on NASA's efforts to implement the recommendations of the *Columbia* Accident Investigation Board (CAIB). Program operations and sustaining engineering costs have not been considered in calculating and describing Return to Flight costs for the reasons provided in the answer above.

However, while program operations and sustaining engineering cost estimates were not specifically enumerated, Administrator O'Keefe's testimony did acknowledge their significance. The Administrator's written testimony indicated that the current cost estimate, provided to the Committee on July 30, 2004, included costs incurred by other agency activities in support of Return to Flight efforts. A majority of these costs is associated with program operations and sustaining engineering. In addition, the written testimony made reference to the reassessment of the Shuttle program and described program activities that are associated with program operations and sustaining engineering. Finally, Administrator O'Keefe discussed the issue of NASA's sustaining engineering efforts in response to a question on Return

to Flight costs from Senator Brownback. Although the hearing was primarily focused on NASA's RTF efforts, the issue of sustaining engineering and operations was addressed. NASA recognizes the importance of these costs, has provided information on these costs to the Committee, and is taking steps to try to control them while ensuring that our ability to safely return to flight is not compromised.

Question 5. Cost increases of $450 million to $760 million over the FY 2005 budget request of $4.3 billion for the Shuttle program have been reported by NASA. This would amount to a total of $4.8 billion to $5.1 billion for FY 2005 alone. There are many who are questioning whether the Shuttle will fly next year and who say that the $5 billion would be wasted. How do you respond to these charges?

Answer. Our current plans have the Space Shuttle flying three missions in FY 2005. There are currently no technical issues that would prevent NASA from accomplishing this plan, which was confirmed by Gen. Stafford during the hearing. Returning to flight is the first step in implementing the Vision for Space Exploration, which uses a stepping-stone approach. It is critical for completing assembly of the International Space Station, which is preparing us for future human exploration.

Question 6. When can we expect to see NASA's amendment to the budget request and how NASA will pay for these cost increases?

Answer. At this juncture, NASA does not plan to submit an FY 2005 budget amendment. NASA intends to pay for the Space Shuttle cost increases within the President's FY 2005 budget request. First, the program will seek to reduce the shortfalls as technical options are closed and cost estimates can be refined. Operations and sustaining increases are being reassessed to ensure that only essential activities continue beyond RTF. The agency will incrementally evaluate progress to reduce the shortfalls, and take action to reallocate its resources to support RTF as required. NASA is re-evaluating the Shuttle Service Life Extension Program (SLEP) to determine which activities can be canceled or deleted based on the program's revised service life. NASA may have to reallocate funds from lower priority activities, corporate accounts, or other program reserves.

Question 7. Do you foresee any technical challenges that would prevent NASA from meeting the "Return to Flight" recommendations of the *Columbia* Accident Investigation Board's report?

Answer. NASA currently sees no insurmountable challenges to safely return the Space Shuttle fleet to flight. There is a significant amount of testing to verify analyses and certification processes to complete; however, planning for these activities is in place. Unanticipated results from testing and launch preparation may impact milestones leading to the Return to Flight launch and, if necessary, we will revise the milestone date to assure a safe mission.

Question 8. One issue of critical importance to the Return to Flight program is on-orbit repair of the Reinforced Carbon-Carbon panels on the leading edge of the Shuttle wing and the tiles on the orbiter. As you know, it was a hole in a Reinforced Carbon-Carbon panel that caused the destruction of *Columbia*. What is the status of NASA's efforts to develop on-orbit inspection and repair capabilities?

Answer. Taken together, Thermal Protection System (TPS) inspection and repair, including those processes associated with Reinforced Carbon-Carbon (RCC) panels, represent one of the most challenging and extensive Return to Flight tasks. NASA's near-term TPS risk mitigation plan calls for:

- Space Shuttle vehicle modifications to eliminate the liberation of critical debris.
- Fielding improved ground and vehicle-based cameras.
- Developing ship-based radar and airborne sensors for ascent debris tracking.
- Adding wing leading edge (WLE) impact sensors for debris detection and damage assessment.
- On-orbit TPS surveys using the Shuttle Remote Manipulator System (SRMS) and Space Station.
- Remote Manipulator System (SSRMS) cameras.
- International Space Station (ISS) crew observations during Shuttle approach and docking.

Techniques for repairing RCC panels using an Extra-Vehicular Activity (EVA) (space walk) are under development. The combination of these capabilities will help to ensure a low probability that critical damage will be sustained, while increasing the probability any damage that does occur can be detected and the consequences mitigated in flight. NASA's long-term TPS risk mitigation steps will refine and improve all elements of the near-term plan, ensuring an effective inspection and repair capability.

The first step in structuring effective inspections is to establish baseline criteria for resolving critical damage. NASA has defined preliminary critical damage inspection criteria that form the basis for TPS inspection and repair development work. The detailed criteria are evolving based on ongoing tests and analyses. Our goal is to define damage thresholds for all TPS zones, below which no repair is required before entry. These criteria are a function of the damage surface dimensions, depth, and entry heating at each location on the vehicle.

A combination of Shuttle and ISS assets will be capable of imaging TPS damage in all areas. The Orbiter Boom Sensor System (OBSS) project is currently developing a sensor system that will be flown on the first flight and used to inspect the RCC on the WLE and nose cap. The OBSS comprises sensors on the end of a boom system that is launched and installed on the orbiter's starboard sill. The boom will be used in conjunction with the SRMS to inspect WLE RCC and the nose cap prior to docking with ISS. After docking, the OBSS will be used to further inspect any suspect areas on the orbiter. Additionally, the boom will have the capability to support an EVA crewmember, if needed, to support inspection activities. Current plans call for the OBSS to carry a Laser Dynamic Range Imager (LDRI) sensor to detect damage to the RCC. A second sensor system, called the Laser Camera System (LCS), which has a higher capability compared to the LDRI, will also be flown as part of the OBSS if development can be completed to support Return to Flight. Critical damage to the RCC will be detectable on-orbit with the OBSS.

The main challenges to repairing RCC are maintaining a bond to the RCC coating during entry heating and meeting very small edge step requirements. The RCC repair project is pursuing two complementary repair concepts that together will enable repair of RCC damage of a wide range: Plug Repair and Crack Repair. Plug Repair consists of an insert intended to repair holes in the WLE with sizes from 0.5 inches to 4 inches in diameter. Crack Repair uses a material application intended to fill cracks and small holes in the WLE. Both concepts are expected to have limitations in terms of damage characteristics, damage location, and testing/analysis. Schedules for design, development, testing, evaluation, and production of these concepts are in work.

NASA is continuing research and development on a long-term, more flexible RCC repair technique for holes over 4 inches in diameter. This effort is still in the concept definition phase and is much less mature than the tile repair material study. NASA is evaluating concepts across 6 NASA centers, 11 contractors, and the United States Air Force Research Laboratory. Initial NASA development of a third RCC repair technique, rigid overwrap, encountered significant technical challenges. As a result, the Space Shuttle program (SSP) recommended that the rigid overwrap be deferred in favor of an expanded research and development project to develop alternative repair techniques for large holes. On June 9, 2004, the Space Flight Leadership Council approved the SSP recommendation and directed the SSP to develop plug and crack repair to the greatest extent practicable for the March 2005 launch of STS–114.

Question 9. A recent Congressional Budget Office report entitled, "A Budgetary Analysis of NASA's New Vision for Space Exploration" dated Sept. 2, 2004, indicates that the human lunar mission could slip by as much as 1 year for each year that the Shuttle's operations are extended. Do you agree with that assessment?

Answer. Yes. Since the majority of Exploration Systems development costs will come from funds freed up by the retirement of the Space Shuttle program, it is correct to assume that any delay in the Shuttle retirement would affect the human lunar mission.

Question 10. The *Columbia* Accident Investigation Board recommended that using the Shuttle beyond 2010 would require re-certification of the orbiters. It now appears even more challenging for NASA to complete assembly of the International Space Station before that time. What are your plans for re-certification?

Answer. NASA fully plans to meet the Vision for Space Exploration's plan for retiring the Space Shuttle, by the end of this decade, following the completion of its role in assembling the ISS. To prepare for the contingency that the Shuttle may need to operate beyond 2010, NASA is reassessing the need to recertify Space Shuttle systems, subsystems, or components in line with the recommendations of the *Columbia* Accident Investigation Board.

Question 11. Are you developing any cost estimates of what it would take to recertify the orbiters?

Answer. NASA fully plans to meet the Vision for Space Exploration's plan for retiring the Space Shuttle, by the end of this decade, following the completion of its role in assembling the ISS. NASA has not yet developed cost estimates for recertification.

Question 12. General Stafford states in his written statement that a universal concern for the Return to Flight Task Group is the personnel requirements to meet the *Columbia* Accident Investigation Board recommendations. Can you comment on NASA's use of the NASA Flexibility Act to aid the agency in addressing its personnel problems?

Answer. NASA civil servant staffing in support of Return to Flight was essentially completed by the time the NASA Flexibility Act of 2004 became available for the agency's use. However, the new flexibilities provided by this Act will benefit the Program's ability to manage human capital issues in the future. For example, NASA plans to use the new retention and recruitment tools to ensure that critical skills and expertise of the current workforce are not lost.

Question 13. Several years ago, a number of management reports identified NASA's cost estimating capabilities to be lacking. What has NASA done to improve upon this critical skill?

Answer. GAO recently completed a review of NASA's cost estimating capabilities. NASA is in the process of responding to and implementing recommendations from this report. They include:

1. Developing an integrated plan that, at a minimum, includes: specific actions for ensuring that guidance is established on re-baselining, and that re-baselining is consistently applied to provide accountability among programs; true earned value management is used as an organizational management tool to bring cost to the forefront in NASA's management decision-making process; acquisition and earned value management policies and procedures are enforced; and, staff and support for cost-estimating and earned value analyses are effectively used.

2. Establishing a NASA Cost Estimating Review Board (CERB) similar to the Department of Defense's Cost Analysis Improvement Group (CAIG) to ensure a disciplined cost estimating review process for future NASA acquisitions. On July 7, 2004, the NASA Headquarters Cost Analysis Division received the go-ahead from the Agency Program Management Council (PMC) for full implementation of its Continuous Cost-Risk Management (CCRM) initiative that integrates cost estimating and earned value with risk management and feedback. This will provide project managers with the highest quality cost management information to ensure successful project cost management.

3. Establishing a standard framework for developing life-cycle cost estimates. The framework will require each program or project to base its cost estimates on a full life-cycle for the program—including all direct and indirect costs for operations and maintenance and disposal as well as planning and procurement—and on a work breakdown structure that encompass both in-house and contractor efforts; development of the Cost Analysis Data Requirement (CADRe) that includes not only an equivalent to the Department of Defense's CADR but also requires the NASA project manager to additionally provide an annually updated set of key cost-driving technical parameters that can be used to produce a Life-Cycle Cost Estimate (LCCE) along with the requirement for an annual LCCE; prepare an independent government estimate at each milestone of the program; and, conduct a cost-risk assessment that identifies the level of uncertainty inherent in the estimate.

Question 14. The projected cost increases of $450 to $760 million over the FY 2005 budget are related specifically to Return to Flight activities and implementation of *Columbia* Accident Investigation Board recommendations, and do not include the costs associated with Shuttle mission execution and transition activities that will begin in the next few years.

Answer. As a point of clarification, the $450 to $760 million estimated cost increase for FY 2005 does include the estimated $357 million increase associated with program operations and sustaining engineering.

Question 15. What uncertainties—both within and outside of NASA's control—must be resolved before the agency can provide Congress with an accurate cost estimate of Shuttle program activities through its retirement, including RTF, CAIB, and mission execution and transition activities and workforce needs? When does NASA anticipate including costs of Shuttle mission execution, transition activities, and associated workforce needs in a budget request?

Answer. While NASA is moving rapidly to close on the technical responses to the CAIB recommendations, the total impact of *Columbia* on the agency cannot be fully assessed until after the first few Space Shuttle missions are flown. Only then can NASA assess the effectiveness of its technical solutions and determine the level of effort needed in all areas to assure safe flight through the end of the program. In

addition, until the Space Station final configuration and assembly sequence is agreed upon, the number of Shuttle flights required will not be known. In practical terms, the soonest NASA might be able to submit a definitive budget through the program's retirement would be in its FY 2007 budget request, since the FY 2006 request will be submitted before the first RTF mission.

Question 16. Given the uncertainties surrounding Shuttle activities and NASA's issues related to cost estimating in the past, what assurance can NASA provide Congress that the out-year cost estimates related to the program are well founded?

Answer. Over the last 2 years, NASA has greatly enhanced its cost estimating capabilities. The issue with the current Shuttle cost estimates is not a lack of resources or estimating acumen, but the maturity of the technical solutions to the RTF challenges. It is only in the last part of FY 2004 that NASA started to close on its RTF solutions and to begin incorporating them into flight hardware production, operations procedures, and revised, integrated mission risk assessments. As will always be the case, sound cost estimates must follow sound technical content. Accordingly, as NASA completes the work delineated in its RTF plan and once actual flight experience is gained, the estimates for all years will be reassessed and revised.

Question 17. What activities would you characterize as high risk for the Shuttle program in that, they could have a significant impact on Shuttle costs in the future?

Answer. As NASA closes on its technical solutions to the CAIB recommendations; the issues that have the greatest impact on cost in the next year are thermal protection system inspection and repair, and the effectiveness of the debris mitigation actions on the external tank. For the long term, workforce increases to support program-wide integrated engineering and mission assurance efforts are projected to require greater resources than in the years prior to *Columbia* and are the focus of ongoing evaluation as the agency approaches its first RTF missions.

Question 18. According to documents provided to the Congress, NASA anticipates using funds originally intended for the Shuttle Life Extension Program (SLEP) to offset a portion of the budget shortfall in FY 2005. Has NASA performed a risk assessment to determine the impact of not implementing or postponing needed upgrades to the Shuttle? If not, why not?

Answer. Decisions to continue with a long-term complex vehicle modification in the limited available time for Space Shuttle operations must be viewed in the context of relative risk. Major modification of a developmental vehicle late in its mission life requires additional attention after the lessons learned from the CAIB report. Decision packages related to the two remaining primary vehicle upgrade modifications (Cockpit Avionics Upgrade and Advanced Health Monitoring Phase II) are currently in coordination. These packages are based on the diligent evaluation of a wide range of technical issues and include inputs from diverse program perspectives. They specifically address the relative risk of continuing the project against the remaining potential for benefits.

Question 19. What approved SLEP upgrades does this transfer of funds affect and how did NASA make the determination that these upgrades could be delayed or abandoned?

Answer. The SLEP funding profile is based on a "needs" evaluation of what is necessary to safely sustain Shuttle operations through ISS assembly complete. Decisions on the status of future upgrades are based on the processes defined above.

Question 20. Was a sensitivity analysis performed on how risks might rise (from such delay or abandonment of specific SLEP upgrades) if the Shuttle was retired later than the expected 2010–2011 time-frame?

Answer. NASA fully plans to meet the Vision for Space Exploration's plan for retiring the Space Shuttle, by the end of this decade, following the completion of its role in assembling the ISS. Because upgrades are primarily implemented during orbiter major modification periods, a delayed Space Shuttle retirement date due to manifest changes would essentially delay the implementation of the upgrades as well, resulting in very little difference in risk.

Question 21. Based on NASA's proposed strategy, it appears that NASA is funding near-term RTF activities at the expense of long-term safety and operations of the Shuttle. Is this the case?

Answer. No. The decisions on vehicle modification were made based on the relative risk of continuing the upgrade in terms of integrated program and technical risk against implementation late in the Shuttle's mission life. Resource constraints, while not a decision driver, were an area of consideration.

Question 22. RTF activities have resulted in a rapid increase in activity, including the need for an increase in the Shuttle workforce to support such activities. Once

RTF has been accomplished, will this level of workforce be maintained to ensure that the critical skills necessary to support mission execution and transitioning activities are available? If the workforce is reduced following successful RTF, how will NASA ensure that critical skills will be available until the Shuttle fleet is retired? Has NASA examined the long-term impacts of this increase and then possible decrease in workforce numbers in light of the planned retirement of the Shuttle at the end of the decade?

Answer. NASA is assessing the post-RTF workforce requirements to determine long-term (not just RTF) impacts to operations in complying with CAIB recommendations while balancing the transition activities associated with Space Shuttle retirement. Maintaining the critical skills related to executing the mission and providing the appropriate workforce to support transition activities is a key part of this effort. NASA has benchmarked similar programs for transition that have dealt with a retirement of assets. The lessons learned from these reviews are being incorporated into the implementation plan being developed by the Space Shuttle program. NASA has also engaged the National Academy of Public Administration (NAPA) to assess the adequacy of this implementation plan as it relates to the transitioning of the workforce. Furthermore, the Government Accountability Office (GAO) was requested by Senators McCain and Hollings to review NASA's plans for the workforce with the pending Shuttle retirement. NASA believes the efforts of the Program to develop a post-RTF mission execution and transition plan, combined with the assessment by NAPA and review by GAO, will ensure adequate critical skills retention through the end of mission execution and transition activities.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN MCCAIN TO LIEUTENANT GENERAL THOMAS P. STAFFORD

Question 1. Do you believe NASA will be able to return the Shuttle to flight next spring? What analysis have you done to support your position?

Answer. NASA has laid out a milestone-driven schedule, that if met, will lead to a launch in the March/April time-frame. As I indicated in my written testimony, the Task Group's Management, Technical, and Operations Panels have conducted extensive fact-finding activities at all levels within the agency and its contractor team. This has included participating in teleconferences, reviewing documents, conducting interviews, receiving formal and informal briefings, and observing tests, simulations, and program reviews. Based on assessment of their fact-finding activities, task group believes that NASA continues to make significant progress in meeting its milestones. However, challenging work lies ahead for NASA, the impacts of Hurricanes Francis and Ivan are not yet known, and there is little time available in the schedule for additional unplanned work. Therefore, while it is still possible that NASA could be in a position to launch this spring, I would judge the agency's plan to launch in the current March/April planning window as optimistic and there is a likelihood that some adjustment may be necessary.

Question 2. Your written statement indicates that the Task group has conditionally approved 5 of the 15 "Return To Flight" recommendations. You have also identified in your written statement the actions that are necessary to completely close out these items. Do you consider these remaining action items for the conditionally approved recommendations to be of a concern for the Return to Flight date?

Answer. NASA has planned or is in the process of taking the actions identified as conditions for closure of the five "conditionally closed" recommendations. The Task Group has no technical concerns in this area and does not expect implementation of these conditions to impact the Return to Flight date.

Question 2a. Is it accurate to say that none of the 15 "Return To Flight" recommendations have been completely closed out more than 1 year after the final report from the *Columbia* Accident Investigation Board?

Answer. NASA has made significant progress toward meeting the intent of the CAIB in all 15 recommendations: five have been conditionally closed. However, none have been fully closed to date.

Question 3. Have you reviewed the cost estimates for the Return to Flight activities in FY 2005 and do you agree with them? What analysis have you done to support your position?

Answer. Although the Task Group is charged with assessing the consistency of NASA's flight schedule with available resources, an evaluation of the cost estimates for Return to Flight is outside the scope of the charter for the Return to Flight Task Group.

Question 4. Can you further discuss NASA's technical challenges for providing on-orbit inspection and repair capabilities for the Shuttle? Is the "safe haven" approach you discussed in your written statement a viable alternative?

Answer. The Task Group is not aware of any technical challenges to on-orbit inspection based on the current requirements. There is significant forward work to deliver and validate this inspection capability. Several technical challenges remain for both RCC and tile repair techniques, materials and overall capabilities. NASA is working very hard to address these concerns.

Safe haven is an emergency contingency that will only be considered after all other alternatives have been exhausted. As such, NASA has identified the systems and consumables required on ISS to provide an engineering estimate that provides expected capability at the time of Shuttle launch. This analysis is updated continuously to reflect current system status and changes to consumables that might affect duration. In addition, the necessary crew rescue vehicle mission has been established.

Question 5. You noted in your written statement that personnel requirements of the Return to Flight program is a universal concern for the Task Group. Do the required staff talents exist within the agency and its contractors? How much of a hindrance is this toward successfully returning the Shuttle to flight?

Answer. In responding to the recommendations of the CAIB, NASA is establishing various new organizations including the NASA Engineering and Safety Center, the Independent Technical Authority, and the Space Shuttle Systems Engineering and Integration Office, and strengthening others. The Task Group's expressed concern was that these organizations will require personnel with special qualifications and experience; that these personnel would of necessity be drawn largely from a limited pool within NASA and its contractor team; and that this could put a strain on resources available to perform other important Space Shuttle Return to Flight activities. NASA is still in the process of establishing and staffing some of these new organizations. The Task Group has not identified any deficiencies that will impact Return to Flight. The Task Group will need to continue to monitor this concern.

Question 6. In its January report, the Return-To-Flight Task Group expressed concern that NASA "has not been timely in some of their responses to Task Group requests for information." Have these concerns been addressed, and is the Return To Flight Task Group getting the information in a timely manner?

Answer. NASA has worked closely with the Task Group to refine its process for and increase its focus on responding to the Task Group's requests for information. Overall, the new process has resulted in a more timely response to the Task Groups requests.

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