NASA'S FISCAL YEAR 2004 BUDGET REQUEST

HEARING

BEFORE THE

COMMITTEE ON SCIENCE
HOUSE OF REPRESENTATIVES

ONE HUNDRED EIGHTH CONGRESS

FIRST SESSION

FEBRUARY 27, 2003

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CONTENTS

February 27, 2003

NASA'S FISCAL YEAR 2004 BUDGET REQUEST

THURSDAY, FEBRUARY 27, 2003

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE,
Washington, DC.

The Committee met, pursuant to call, at 10:05 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Sherwood L. Boehlert (Chairman of the Committee) presiding.

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, DC 20515

Hearing on

NASA's Fiscal Year 2004 Budget Request

Thursday, February 27, 2003
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

WITNESS LIST

Honorable Sean O'Keefe
Administrator
National Aeronautics and Space Administration

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HEARING CHARTER

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

NASA's Fiscal Year 2004 Budget Request

THURSDAY, FEBRUARY 27, 2003
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On Thursday, February 27th at 10:00 a.m., the Science Committee will hold a Full Committee hearing on *NASA's Fiscal Year 2004 Budget Request.* The hearing will examine NASA's plans and programs and the rationale for the funding levels in the agency's FY 2004 budget. The Committee will receive testimony from the Honorable Sean O'Keefe, NASA Administrator.

The hearing is not intended to review the status of the ongoing investigation into the *Columbia* accident, but will, in addition to examining the FY 2004 budget request, examine how the grounding of the Space Shuttle fleet will affect other programs.

2. Budget Highlights

NASA's FY 2004 budget request is $15.5 billion which is a 3.1 percent increase over last year's request and less than a one percent increase from the FY 2003 appropriation of $15.3 billion. FY 2003 levels appropriated for each program are included in the table on the last page.

3. Major Issues

Space Shuttle tragedy ripples through NASA programs: NASA grounded the Space Shuttle fleet on February 1st following the tragic accident that destroyed the Space Shuttle *Columbia* and killed the seven astronauts on board. Clearly, this tragedy dramatically changes NASA's current plans as well as plans for FY 2004 and beyond. An independent panel of experts is investigating the cause of the accident. Meanwhile, NASA and Congress face many near-term policy questions regarding the Space Shuttle, the International Space Station (ISS), and other related programs. Specific near-term policy questions include: What strategy should guide the ISS program while the Shuttle is grounded? What contingency plans is NASA studying if the Shuttle is grounded for an extended period? Should NASA accelerate plans to develop a replacement for the Shuttle system? What are the funding implications for NASA's budget this year and over the next few years?

Project Prometheus: Project Prometheus is intended to develop and demonstrate nuclear power and propulsion systems to enable a satellite to conduct an extended tour of the moons of Jupiter, which are suspected of having oceans underneath their icy crusts. Project Prometheus is an acceleration of the Nuclear Systems Initiative begun last year. NASA has requested $279 million for Project Prometheus ($3 billion over five years), of which $186 million ($1 billion over five years) comes from the Nuclear Systems Initiative and $93 million ($2 billion over five years) is for a first flight mission, the Jupiter Icy Moon Orbiter (JIMO), to be flown within a decade. If successful, nuclear power and propulsion technology would enable a much more robust solar system exploration program. Travel times to distant planets and asteroids would be dramatically reduced and probes would not be limited to short fly-by missions, but could orbit and collect data for extended periods. Previous attempts by NASA to develop nuclear propulsion systems have not succeeded. Key issues include the feasibility, safety, and cost of the concept. In addition, some may question whether NASA should focus first on funding for other programs before beginning such an initiative.

Aeronautics R&D Funding: The Congressionally-created Commission on the Future of the Aerospace Industry chaired by former Science Committee Chairman Bob Walker, reported last November that the nation needs to take immediate action to transform the U.S. air transportation system and to deploy a new highly automated air traffic management system. The Commission recommended the creation of an

interagency Joint Program Office to better focus federal investments in aeronautics, particularly for critical long-term research.

NASA proposes to cut funding for aeronautics by 4.5 percent over the next five years while most other programs are being increased. Similarly, the Federal Aviation Administration (FAA) proposes to cut its Research, Engineering, and Development account by nearly 20 percent from $124 million in FY 2003 to $100 million in FY 2004. While NASA, FAA and the Department of Defense have taken initial steps to create a Joint Program Office as recommended by the Commission, the budgets for aeronautics at NASA and FAA clearly reflect a dwindling financial commitment.

Restructured Space Launch Initiative (SLI) and the Orbital Space Plane (OSP): With the decline of the commercial launch market, NASA's launch requirements focus solely on servicing the International Space Station. Responding to criticism from the NASA Advisory Committee and recognizing that its current plan would not meet its technology requirements, NASA developed a new Integrated Space Transportation Plan (ISTP) and in November 2002, NASA submitted to Congress an amended FY 2003 budget request. Although total funding for NASA remained unchanged, the budget amendment reflected significant changes to its plans for new launchers, the Space Shuttle and ISS.

In its budget amendment, NASA shifted money from the SLI program into the Space Shuttle and Space Station, and created a new program called Orbital Space Plane (OSP). The OSP is intended to affordably meet crew rescue and crew transportation needs for the Space Station. NASA is in the early stages of this program and the budget amendment was submitted before all the requirements had been developed for the program. NASA finally released the initial set of requirements in early February.

The OSP represents a substantial new commitment to develop a new manned spacecraft and the cost, requirements, and plans should be carefully evaluated to ensure that they are aligned with NASA's needs. Prior to the *Columbia* accident, NASA projected that the crew rescue version of the OSP would be available in 2010 and the crew transfer version in 2012. A critical issue is whether plans for the OSP should be (and could be) accelerated to supersede the Space Shuttle more quickly.

NASA's Workforce: In its most recent report on major management challenges, the General Accounting Office (GAO) placed the management of human capital as one of the top challenges facing NASA. The size of NASA's workforce has been cut significantly over the past decade, dropping from approximately 25,000 in FY 1993 to slightly more than 18,000 in FY 2002. NASA has tried to retain workers with key skills, but has not always been successful because it has relied on voluntary departures to reduce its workforce. The problem is likely to get worse with approximately 15 percent of NASA's science and engineering workforce eligible to retire. Within five years, almost 25 percent of the current workforce will be eligible to retire. Over the next few years the absence of individuals with critical skills could jeopardize NASA's ability to accomplish its mission. Chairman Boehlert will shortly introduce a bill that would give NASA legislative authority to offer additional incentives to retain and recruit people with critical skills. NASA sent up a draft set of proposals last year, and the Chairman's bill is the product of negotiations with NASA over those proposals.

Appropriations Restructuring and Full Cost Accounting: NASA proposes to restructure its appropriations accounts. The new structure is intended to mirror NASA's new strategic plan, which is designed to more closely link budget with performance and to put more emphasis on science and technology capabilities, rather than on specific projects such as the Space Shuttle or Space Station.

For the first time, NASA's programs are in a full cost budget format. Full cost means that all direct and indirect costs are identified and included in a given program budget, including civil service salaries. The objective is to provide a direct link between each program and the infrastructure used to more accurately reflect the true cost of programs.

While these changes may make the budget more revealing over time, they make it extremely difficult to compare the FY 2004 proposal with those from previous years. For example, full cost accounting often makes it appear that programs have been increased substantially when in fact the larger numbers may simply reflect an accounting change in which institutional support has been added to the program's funding line.

The problem in making comparisons is exacerbated by the frequent previous changes NASA has made in its budget presentation. These changes make it difficult for Congress to conduct oversight of various programs—particularly the Space Shut-

tle and the ISS by making it difficult if not impossible to make year-to-year budget comparisons. (This is one reason it is difficult to answer the seemingly simple question of how much has been spent on Shuttle safety.)

NASA has provided the Committee with FY 2003 request numbers that have been adjusted to reflect "full cost" in order to facilitate comparisons with the FY 2004 budget request. NASA cannot, however, convert the FY 2004 budget request into the format that it previously used. The inability to convert previous years' budgets will make it very difficult to do historical budget analysis.

Integrated Financial Management and Audit: Since 1990 the GAO has identified NASA's contract management as a high-risk activity due to ineffective and often incompatible accounting systems, and nonstandard cost reporting capabilities. Consistent, timely financial information is not available to program managers, making it difficult to ensure that program budgets are executed as planned.

NASA failed its FY 2001 audit last year but was issued a clean opinion on its financial statement for FY 2002. Nonetheless, many issues remain regarding improvements to NASA's accounting and financial management system. To help address these issues, NASA is implementing an Integrated Financial Management system to provide managers with the financial tools to more effectively manage their programs. This new system has experienced some problems during its development and pilot testing, but NASA expects that the core portion of the system will be rolled out across the agency by the end of the first quarter of FY 2004. NASA believes the system will be fully implemented across the agency by the end of FY 2005.

4. Details of NASA's FY 2004 Budget

Space Science

The FY 2004 request is $4.0 billion, which includes a $539 million or 15.5 percent increase above the FY 2003 request (full cost). The Space Science Enterprise seeks to answer fundamental questions about life in the universe, including how the solar system may have originated, whether there are planets with similar environmental systems to Earth's, and where signatures of life can be found. Space Science also seeks to understand how the universe began and evolved, including how stars and galaxies formed. The Space Science program includes three new initiatives.

New Initiative—Project Prometheus: Discussed in Section 3 above.

New Initiative—Optical Communications: The budget request includes $31 million ($233 million over five years) to fund a new initiative in Optical Communications. Optical Communication offers the potential for dramatic increases in speed over conventional radio communications. NASA's program builds on advances in laser communications at the Department of Defense and is aimed at demonstrating the technology on a telecommunications satellite that would send data back to Earth while orbiting Mars in 2009.

New Initiative—Beyond Einstein: The budget request includes $59 million ($765 million over five years) to answer vexing questions that have been left unanswered by Albert Einstein's theories. To accomplish this, NASA proposes a series of small spacecraft to take measurements of gravity waves and observe black holes, and to conduct investigations of the structure of the universe.

Earth Science

The FY 2004 request is $1.6 billion, which includes a $58 million or 3.5 percent cut from the FY 2003 request (full cost). The mission of the Earth Science Enterprise is to develop a scientific understanding of the Earth system to improve prediction of climate, weather, and natural hazards. The decrease is the result of major development programs that are past their peak spending and are preparing for launches in 2004, including AURA, Cloudsat, and Calipso. NASA has requested $96 million for the NPOESS Preparatory Project (NPP) under development in partnership with the National Oceanographic and Atmospheric Administration (NOAA) and the Department of Defense. NPP transfers critical research instruments to operational agencies and maintains data continuity for NASA-sponsored scientific investigation. NASA has also requested $60 million for the Landsat data continuity mission, which is an innovative program to seek partnerships with industry to continue receiving critical land remote sensing data. The budget request also includes $524 million for research and modeling that help answer critical scientific questions on climate change to aid policy and economic decision-makers.

New Initiative—Climate Change Research Initiative Acceleration: The budget request includes $26 million ($72 million over five years) to fly an advanced in-

strument, called a polarimeter,[1] to enhance the ability to evaluate mechanisms affecting climate change not associated with carbon dioxide. Specifically, the instrument will measure methane, tropospheric ozone, aerosols, and black carbon. This initiative accelerates the launch of this instrument by about four years.

Biological and Physical Research

The FY 2004 request is $973 million, which includes a $60 million or 6.5 percent increase over the FY 2003 request (full cost). NASA's Biological and Physical Research (BPR) Enterprise conducts interdisciplinary fundamental and applied research that takes advantage of the unique environment of space to study biological and physical processes. BPR provides funding for the research to be conducted on the Space Station, as well as other platforms. As a result of the grounding of the Space Shuttle fleet, BPR's budget outlook and near-term plans are unclear.

New Initiative—Human Research Initiative: The budget request includes $39 million ($374 million over five years) to perform research with the goal of extending the ability of crew to safely conduct missions over 100 days beyond low Earth orbit (ISS is in low Earth orbit) where radiation levels are significantly higher.

Aeronautics

The FY 2004 request is $959 million, which includes a $10 million or one percent increase over the FY 2003 request (full cost). NASA plans to cut Aeronautics by $43 million or 4.5 percent over the next five years. The Aeronautics program is intended to invest in technologies to create a safer, more secure, environmentally friendly, and efficient air transportation system. As stated in Section 3, NASA and FAA's investments in aeronautics R&D are dwindling at a time when many, including the Aerospace Commission, are calling for increased investment and collaboration.

New Initiative—Aviation Security: The budget includes $20 million ($195 million over five years) to address critical aviation security needs, such as airspace protection, damage tolerant structures and autonomous flight controls.

New Initiative—National Airspace System Transition Augmentation: The budget includes $27 million ($100 million over five years) for NASA to work in cooperation with FAA to transition technology needed to develop the next generation National Airspace System. The goal is to increase capacity, efficiency, and security.

New Initiative—Quiet Aircraft Technology: The budget includes $15 million ($100 million over five years) to accelerate development and transfer of technologies to cut perceived noise in half by 2007 compared to 1997 levels.

Education Programs

The FY 2004 NASA Education budget request is $170 million, which includes a $10 million or 6.3 percent increase over the FY 2003 request (full cost). NASA requested $78 million for education programs designed to encourage students of all ages to pursue math and science education and the Space Grant and EPSCOR programs. EPSCOR, modeled on a National Science Foundation program, is designed to help institutions in states that traditionally have not received much research funding from the Federal Government. NASA has targeted $92 million for minority university research and education grants. In addition, $55 million in education-related funding is managed by the five other NASA enterprises.

New Initiative—Education Initiative: The budget includes $26 million ($130 million over five years) to establish the Educator Astronaut Program; the NASA Explorer Schools Program, which is designed to provide middle school students with the most recent discoveries and technologies; a Scholarship for Service Program, which would use scholarships to attract new employees; and the Explorer Institutes, to link with informal education centers, such as museums and science centers.

International Space Station

The FY 2004 budget request is $1.7 billion,[2] which includes a $144 million or 7.8 percent decrease from the FY 2003 budget request (full cost). The primary reason for the decreased funding is that development activities are nearly complete and on-orbit operations and research are the focus of planned activities. The budget outlook and plans for the Space Station in the near-term are unclear while the Space Shut-

[1] A polarimeter is a device that measures the polarization of radio waves scattered off the atmosphere. Using polarization data, scientists can determine the concentration of various gases and chemicals.

[2] The $1.7 billion includes institutional support costs (new for FY 2004), but does not include space shuttle and research costs associated with ISS.

tle fleet is grounded. There is no doubt that the Shuttle grounding will have a significant impact on the program and a prolonged grounding of the Shuttle will likely increase the cost of the Space Station program.

Three crew, two Americans and one Russian, are currently on board the Space Station. A Russian Soyuz crew return capsule is currently docked to the Space Station should the crew need to return for any reason. At the hearing, Administrator O'Keefe is expected to address the contingency plans NASA is considering to maintain and proceed with the program.

The Space Station program has been plagued for years with cost overruns and schedule slips. In 2001, NASA revealed that costs would grow by $4.8 billion over the ensuing five years. In response, the Office of Management and Budget directed NASA to drop significant technical content from the program to offset the cost growth. Also, NASA appointed a task force to review ISS program management. The ISS Management and Cost Evaluation (IMCE) Task Force concluded that the program was not credible and made numerous recommendations to restore credibility. In 2002, Administrator O'Keefe, sought to bring the program under control by making several management changes and reforms. He requested help from the Defense Department to establish a credible cost estimate for the remainder of the program, and directed a review and prioritization of the research program.

Today, NASA estimates the cost to complete the Space Station and operate the station until 2016 to be approximately $17 billion.[3] This is in addition to the $20 billion appropriated for the program between 1994 and 2002.

Space Shuttle

NASA's FY 2004 request is $3.9 billion, which includes a $182 million or 4.8 percent increase above FY 2003 request (full cost). In the FY 2003 appropriation, the conferees added $50 million to the President's request to cover the cost of the *Columbia* accident investigation. At this time it is impossible to know when, or if, the cause of the accident will be determined, and what type of corrective measures will be necessary to return the Shuttle to flight. NASA had planned for five Space Shuttle flights in FY 2004 in support of the ISS, but the fleet is now grounded indefinitely. In the near-term, the Space Shuttle program will be assisting the *Columbia* Accident Investigation Board, chaired by Admiral Hal Gehman, Jr. In addition, Space Shuttle program personnel, primarily at the Kennedy Space Center continue to process the payloads planned for this year with the hope that the Shuttle program will not be grounded for a prolonged period. (NASA grounded the Shuttle for 32 months following the *Challenger* accident in 1986.)

The proposed budget includes $379 million of investments ($1.7 billion over five years) in support of the Integrated Space Transportation Plan as part of the Shuttle Service Life Extension Program (SLEP). NASA has combined three programs from last year (Shuttle Safety Upgrades, Supportability, and Infrastructure Revitalization) into the new program. The implementation of the Cockpit Avionics Upgrade, the Advanced Health Monitoring System, and the External Tank friction stir weld projects found in last year's safety upgrades budget continue under SLEP.

The March 2002 annual report of the Aerospace Safety Advisory Panel stated that current budget projections for the Space Shuttle are insufficient to accommodate significant safety upgrades, infrastructure upgrades and maintenance of critical workforce skills over the long-term. Concurrent with the panel's recommendation, Associate Administrator for Space Flight Fred Gregory directed that NASA's Space Shuttle upgrade strategy should be developed to maintain Space Shuttle capability to fly safely beyond the planned phase-out in 2012 and through 2020. The results of this study provided the basis for the FY 2003 budget amendment proposed by NASA last November. Specifically, the amendment proposed the creation of the Service Life Extension Program for Shuttle, in addition to adding funds to bolster reserves on ISS, and creating the Orbital Space Plane program to provide crew rescue and transportation capabilities for ISS.

[3] Does not include institutional support costs, space shuttle costs or research costs associated with ISS.

NASA FY 2004 Budget
(Budget Authority - $ millions)

	Business as Usual	FULL COST					
By Appropriation Account By Enterprise By Theme	Pres. Req. FY03	Est. Pres. Req. FY03	FY04	FY05	FY06	FY07	FY08
Science, Aero, & Exploration	**7,815**	**7,101**	**7,661**	**8,269**	**8,746**	**9,201**	**9,527**
Space Science	**3,414**	**3,468**	**4,007**	**4,601**	**4,952**	**5,279**	**5,573**
Solar System Exploration	976	1,046	1,359	1,648	1,843	1,952	2,054
Mars Exploration	496	551	570	607	550	662	685
Astronomical Search for Origins	698	799	877	968	1,020	1,022	1,061
Structure &Evolution of the Univ.	331	398	432	418	428	475	557
Sun-Earth Connections	544	674	770	959	1,111	1,169	1,216
Institutional	370	--	--	--	--	--	--
Earth Science	**1,628**	**1,610**	**1,552**	**1,525**	**1,598**	**1,700**	**1,725**
Earth System Science	1,249	1,529	1,477	1,440	1,511	1,606	1,629
Earth Science Applications	62	81	75	85	87	94	96
Institutional	318	--	--	--	--	--	--
Biological & Physical Research	**842**	**913**	**973**	**1,842**	**1,887**	**1,118**	**1,143**
Biological Sciences Research	245	304	359	399	453	456	481
Physical Sciences Research	247	351	353	392	380	409	401
Commercial Research & Support	170	254	261	251	254	253	262
Institutional + AM + SAGE	181	3	--	--	--	--	--
Aeronautics	**986**	**949**	**959**	**932**	**939**	**934**	**916**
Aeronautics Technology	541	949	959	932	939	934	916
Institutional	445	--	--	--	--	--	--
Education Programs	**144**	**160**	**170**	**169**	**169**	**170**	**170**
Education	144	160	170	169	169	170	170
Space Flight Capabilities	**7,960**	**7,875**	**7,782**	**7,746**	**7,881**	**8,066**	**8,247**
Space Flight	**6,131**	**6,107**	**6,110**	**6,027**	**6,053**	**6,198**	**6,401**
Space Station	1,492	1,851	1,707	1,587	1,586	1,606	1,603
Space Shuttle	3,208	3,786	3,968	4,020	4,065	4,186	4,369
Space Flight Support	239	471	432	419	402	407	429
Institutional	1,192	--	--	--	--	--	--
Crosscutting Technology	**1,829**	**1,768**	**1,673**	**1,720**	**1,828**	**1,868**	**1,846**
Space Launch Initiative	879	1,150	1,065	1,124	1,221	1,257	1,224
Mission & Sci. Measurement Tec	275	434	458	435	439	439	444
Innov. Tech Trans. Partnership	147	183	169	161	168	172	179
Institutional	528	--	--	--	--	--	--
Inspector General	**25**	**25**	**26**	**28**	**29**	**30**	**31**
TOTAL	**15,000**	**15,000**	**15,469**	**16,043**	**16,656**	**17,297**	**17,806**

Source: NASA FY 2004 budget estimate

Funding Category	FY03 Request	FY03 Approps without 0.65% rescission	FY03 Approps with 0.65% rescission
Human Space Flight	**6130.9**	**6180.9**	**6161.8**
International Space Station	1492.1*	1492.1*	1482.4
Space Shuttle	3208.0	3258.0	3258.0†
Payload and ELV Support	87.5	87.5	86.9
Investment and Support	1178.2	1178.2	1170.5
Space Comm. & Data Systems	117.5	117.5	116.7
Safety, Mission Assur., Engineering	47.6	47.6	47.3
Science, Aeronautics, and Technology	**8844.5**	**9207.7**	**9147.8**
Space Science	3414.3	3524.3	3501.4
Biological, & Physical Research	842.3*	868.8*	863.2
Earth Science	1628.4	1719.0	1707.8
Aero-Space Technology	2815.8	2891.9	2873.1
Academic Programs	143.7	203.5	202.2
Inspector General	**24.6**	**25.6**	**25.4**
TOTAL	**15,000.0**	**15,414.2**	**15335.0**

Source: CRS Report RS21430, Feb 24, 2003, NASA Budget documents and H.Rept. 108-10 to accompany H.J.Res. 2, the Omnibus Continuing Appropriations resolution. Columns may not add due to rounding.

† Space shuttle is exempt from rescission.

* Total funding for the Space station is the sum of the funding under Human Space Flight plus a portion of the funding in Biological and Physical Research. The total FY2003 Request for space station was $1,839 billion. Congress approved that amount and added $8 million for ISS plant and animal habitats.

Chairman BOEHLERT. I am pleased to welcome everyone here today for our annual review of NASA's budget. As I think everyone knows, this hearing was scheduled before the loss of the Space Shuttle *Columbia* on February 1. Still, that tragedy casts a pall over our proceedings today, both emotionally and substantively.

The emotional impact is obvious, and I supposed the substantive ramifications are as well. It is simply impossible to get a clear fix at this point on how much the human space flight program will require in the upcoming fiscal year. That, of course, raises questions about the NASA budget as a whole. Still, we must begin to plan, and there are numerous relevant questions we need to ask today on topics other than the Shuttle investigation or that program's budget.

I should say, though, that having met with Admiral Gehman at length yesterday, I am more convinced than ever that the *Columbia* Accident Investigation Board has the independence and resources it needs to conduct a broad, a thorough, and a useful investigation. The Board does still need some additional members, and I expect that more will be appointed within the next week or so. I look forward to cooperating with Admiral Gehman as the Committee conducts its own bipartisan investigation.

The Gehman investigation could take as long as six months, although portions of it may be completed more quickly. And it is my understanding from Admiral Gehman that there will be a phased release of the reports as they get significant information, it will be released.

But we have to assume that the Shuttle may be grounded for an extended period. I understand that this morning Administrator O'Keefe will reveal how NASA intends to operate the International Space Station while the Shuttle is out of commission. I look forward to being able to pursue any questions that plan may raise.

Still, our primary focus this morning is on the fiscal year 2004 budget submission, which itself raises a host of questions. I am particularly concerned that spending on aeronautics is slated to decline even as the budget calls for healthy increases for the agency overall. I find this somewhat baffling at a time when the need for aeronautics research is so apparent. Unless we are going to rename NASA and call it N-apostrophe-SA, I think the aeronautics budget needs to be rethought.

I should add that while we will be holding additional hearings on aeronautics research at both NASA and the Federal Aviation Administration in the coming weeks, including a Full Committee hearing on May—on March 12 with the Members of the Congressionally-created Aerospace Commission that is—was chaired by one of my predecessors at the Committee, Bob Walker.

I also want to be sure, among other things, that Earth Science Research is getting its due. Earth Science is a critical NASA mission, of enormous scientific utility and vital to sorting out some key questions of practical as well as intellectual consequence, such as the nature of global climate change. And I know all of us here are interested in learning more about NASA's still conceptual plans for the Orbital Space Plane. Obviously, research related to replacing the Shuttle seems more pressing with every passing day.

Finally, I know that Administrator O'Keefe today will highlight NASA's personnel needs, which also have been underscored in several General Accounting Office studies. I believe we must act swiftly to give NASA additional flexibility to recoup and retain employees. I have worked with NASA for several months to come up with legislation to do that, legislation that quite frankly we had hoped to include in the Omnibus Appropriations bill. For various procedural reasons, that path did not work, but I do intend to introduce a NASA personnel bill within the next week or so.

So we have plenty to discuss this morning and, as always, I look forward to hearing from Administrator O'Keefe. As the Administrator knows, we will start with 10 minutes of testimony from him, and then go through as many questions as we can until 11 a.m. when we will break for about an hour or so, so Members can attend an important briefing from Secretary Ridge. Then we will resume for as long as we have to. Mr. Hall.

[The prepared statement of Mr. Boehlert follows:]

PREPARED STATEMENT OF CHAIRMAN SHERWOOD BOEHLERT

I'm pleased to welcome everyone here today for our annual review of NASA's budget. As I think everyone knows, this hearing was scheduled before the loss of the Space Shuttle *Columbia* on February 1st. Still, that tragedy casts a pall over our proceedings today—both emotionally and substantively.

The emotional impact is obvious, and I suppose the substantive ramifications are as well: it's simply impossible to get a clear fix at this point on how much the human space flight program will require in the upcoming fiscal year. And that, of course, raises questions about the NASA budget as a whole. Still, we must begin to plan, and there are numerous relevant questions we need to ask today on topics other than the Shuttle investigation or that program's budget.

I should say, though, that having met with Admiral Gehman at length yesterday, I am more convinced than ever that the *Columbia* Accident Investigation Board has the independence and resources it needs to conduct a broad, thorough and useful investigation. The Board does still need some additional members, and I expect that more will be appointed within the next few weeks. I look forward to cooperating with Admiral Gehman as the Committee conducts its own bipartisan investigation.

The Gehman investigation could take as long as six months—although portions of it may be completed more quickly.

But we have to assume that the Shuttle may be grounded for an extended period. I understand that this morning Administrator O'Keefe will reveal how NASA intends to operate the International Space Station while the Shuttle is out of commission. I look forward to being able to pursue any questions that plan may raise.

Still, our primary focus this morning is on the FY04 budget submission, which itself raises a host of issues. I am particularly concerned that spending on aeronautics is slated to decline even as the budget calls for healthy increases for the agency overall. I find this baffling at a time when the need for aeronautics research is so apparent. Unless we're going to rename NASA and call it N-apostrophe-SA, I think the aeronautics budget needs to be rethought.

I should add that we will be holding additional hearings on aeronautics research at both NASA and the Federal Aviation Administration in the coming weeks, including a full Committee hearing on March 12 with the members of the Congressionally-created Aerospace Commission that was chaired by one of my predecessors at the Committee, Bob Walker.

I also want to be sure, among other things, that Earth Science research is getting its due. Earth Science is a critical NASA mission, of enormous scientific utility, and vital to sorting out some key questions of practical as well as intellectual consequence, such as the nature of global climate change.

And I know all of us here are interested in learning more about NASA's still conceptual plans for the Orbital Space Plane. Obviously, research related to replacing the Shuttle seems more pressing with every passing day.

Finally, I know that Administrator O'Keefe today will highlight NASA's personnel needs, which have also been underscored in several General Accounting Office studies. I believe we must act swiftly to give NASA additional flexibility to recruit and retain employees. I have worked with NASA for several months to come up with

legislation to do that—legislation that, quite frankly, we had hoped to include in the Omnibus Appropriations bill. For various procedural reasons, that path did not work, but I do intend to introduce a NASA personnel bill within the next week or two.

So we have plenty to discuss this morning and, as always, I look forward to hearing from Administrator O'Keefe. As the Administrator knows, we will start with 10 minutes of testimony from him and then go through as many questioners as we can until 11 a.m. when we'll break for about an hour so Members can attend an important briefing from Secretary Ridge. Then we'll resume for as long as we need to.

Mr. Hall.

Mr. HALL. Mr. Chairman, thanks for your opening statement. And I think it was a good statement. I may not be as convinced as you are that we have the independent thrust that we need, and I think that is something that you have taken the lead on, and I appreciate that and I think we need to continue to work together. We—you have been very good at working with us on this side. You are certainly—those staffers have been good. They have worked together. We want to fall in behind this Administrator and circle the wagons and keep a good Space Station going. And, I think, try to go in one direction. I want to do that and I have always wanted to do that, as long as you went in the direction that I wanted to go in. And I guess that hasn't changed a lot for any of us.

I welcome Administrator O'Keefe to today's hearing. And I know that the Members—I wish we could hear about NASA's new budget request under happier circumstances, but we have to deal with the hand that is dealt us and that is what we are doing.

One of the Committee's roles will be to understand the root causes of the *Columbia* accident and to put in safeguards to try to prevent such an accident from happening again. And I think we are looking for causation to protect the future, more than we are looking for blame to curse the past. We have got to get together and we have got to go forward. I think this committee and the leadership of the Chairman of this committee, and the leadership over on this side, in particular Mr. Gordon who chairs the Space Subcommittee are going in the right direction. At—we met yesterday as you did with Admiral Gehman, and he expressed the same determination I think that I have heard from almost everyone, to get the cause of the accident and to identify any contributing factors. This Committee shouldn't shrink from asking any of the touch questions, and I don't believe we are going to do that—and questions of NASA and of ourselves to identify the proper corrective measure.

Our next months or several months we will need to determine the impact of the *Columbia* accident on NASA's budget and programs. And today we are going to try to understand the rationale for some of the budgetary cuts and enhancements that are a part of this request. For example, why is funding for aeronautics R&D cut over the next five years? Why is NASA's Commercial Technology Program being terminated? And why does the Shuttle upgrades budget continue to lag relative to the original plan, while important upgrades continue to be deferred? These are questions I think that we hope have answered today.

And at the same time, the budget request finds room, I see, for some expensive new missions. A year after OMB canceled the one billion dollar Europa Orbiter mission because it was too expensive, NASA is now proposing to take a four billion dollar mission to Ju-

piter's icy moons. Two years after OMB deferred work on the $1.4 billion U.S. Crew Return Vehicle for the International OM—for the International Station, NASA is now proposing to spend what it estimates could be ten times as much on the Orbital Space Plane.

The *Columbia* accident has reinforced the priority of astronaut safety. And I continue to be concerned that we have not more vigorously pursued Space Shuttle crew survivability systems in the 17 years since the *Challenger* accident. And I join the group that can stand there for some blame on that because I have been here those 17 years. Weight issues originally related to the need to be able to lift Space Station modules into orbit—that may not be relevant now that we are nearing the end of the Space Station assembly, and cost issues need seem to be examined in the light of NASA's willingness to find money to undertake other expensive new initiatives.

A lot of the same arguments apply to the U.S. Crew Return Vehicle. The U.S. had a program to develop a U.S. CRV for the International Space Station. In fact, developing such a rescue vehicle is a U.S. responsibility under the international agreements governing the Space Station program. So those are things, and NASA said that Orbital Space Plane will be—will supplement, not replace the Space Shuttle. We need to hear more about that. I don't believe I have used much over half my time, Mr. Chairman; I want to yield the time I have remaining to the ranking Member of the Space Committee, Mr. Gordon.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF REPRESENTATIVE RALPH M. HALL

Good morning. I want to welcome Administrator O'Keefe to today's hearing. I know that all the Members wish that we could be hearing about NASA's new budget request under happier circumstances.

One of this committee's roles will be to understand the root causes of the *Columbia* accident and to put in safeguards to try to prevent such an accident from happening again. Yesterday, I met with Admiral Gehman, the head of the *Columbia* Accident Investigation Board. He expressed his determination to get to the cause of the accident and to identify any contributing factors. This committee should not shrink from asking tough questions of NASA—and of ourselves—to identify the proper corrective measures.

Over the next many months we will need to determine the impact of the *Columbia* accident on NASA's budget and programs. Today we will try to understand the rationale for some of the budgetary cuts and enhancements that are part of this request. For example, why is funding for aeronautics R&D cut over the next five years? Why is NASA's Commercial Technology program being terminated? And why does the Shuttle upgrades budget continue to lag relative to the original plan, while important upgrades continue to be deferred?

At the same time, the budget request finds room for some expensive new missions. A year after OMB canceled the *one* billion dollar Europa Orbiter mission because it was too expensive, NASA is now proposing to undertake a *four* billion dollar mission to Jupiter's icy moons. Two years after OMB deferred work on the $1.4 billion U.S. Crew Return Vehicle for the International Space Station, NASA is now proposing to spend what it estimates could be ten times as much on an Orbital Space Plane.

The *Columbia* accident has reinforced the priority of astronaut safety. I continue to be concerned that we have not more vigorously pursued Space Shuttle crew survivability systems in the 17 years since the *Challenger* accident. Weight issues originally related to the need to be able to lift Space Station modules into orbit may not be relevant now that we are nearing the end of the Space Station assembly, and cost issues need to be examined in the light of NASA's willingness to find the money to undertake other expensive new initiatives.

Much the same arguments apply to the U.S. Crew Return Vehicle (CRV). The U.S. *had* a program to develop a U.S. CRV for the International Space Station. In

fact, developing such a rescue vehicle is a U.S. responsibility under the international agreements governing the Space Station program. OMB deferred the CRV project two years ago, and NASA canceled all work related to it last year. Now we are told that if we approve the "multipurpose" Orbital Space Plane project, we will have a CRV—but not until the end of the decade and at a cost perhaps ten times higher than the estimated cost of the X–38 based CRV fleet. The logic of that approach eludes me.

NASA has said that the Orbital Space Plane will supplement—not replace—the Space Shuttle. Doesn't that mean that we will be flying both the Shuttle and the Orbital Space Station to and from the Space Station? If so, aren't we and our International Partners locking ourselves into higher Space Station operating costs? This doesn't sound like a good idea to me.

I have an even more fundamental problem with the decision to cancel the dedicated U.S. CRV in favor of the so-called "multipurpose" Orbital Space Plane. We are now facing serious decisions on the future of the Space Station due to the grounding of the Shuttle fleet for an indefinite period. At least we have a means of evacuating the Space Station crew if necessary. What happens if we build the "multipurpose" Orbital Space Plane system? We then are dependent on the same vehicle design and subsystems for both Space Station crew rescue and crew transport to and from the Space Station. When we have the inevitable problem with the Orbital Space Plane (as we have had on multiple occasions with the Space Shuttle fleet over the years), we will not only have to ground the Orbital Space Plane crew transfer vehicle fleet but also suspend use of the Orbital Space Plane crew rescue vehicles attached to the Space Station until we determine whether or not there is a systemic problem. That is the increased vulnerability that comes from dependence on a common vehicle design to meet different missions. I don't think that's a vulnerability we should or need to accept.

I could raise additional concerns, but the fundamental question is whether we are willing to delay developing systems that could increase the survivability of our Shuttle and Space Station astronauts in the event of an emergency or whether we instead should try to provide that extra protection as soon as practicable. I think that the responsible answer to that question is obvious, and I intend to introduce legislation in the very near future to address the problem.

I would also note that Mr. Lampson is introducing legislation today which would promote the safety and viability of the Space Station and its crew.

Thank you, and I yield back the balance of my time.

Chairman BOEHLERT. You have 13 seconds left, but we will allow Mr. Gordon a couple of minutes, and we will also allow Mr. Rohrabacher a couple of minutes.

Mr. GORDON. Well, in my 13 seconds, let me just commend our Chairman for setting up a truly bipartisan, bicameral approach to the investigation in the process that this committee is going to take, and also for the proceedings that you have laid out today. If in addition to that you are giving me two extra moments, I will add my welcome to Administrator O'Keefe and commend you for the sensitivity that you and NASA have demonstrated in working with the families of the astronauts. I think you have done a good job.

Let me also commend you on the changes that you have made to what I think was pretty well considered universally a flawed charter document for an independent Commission. I think you have made some positive changes. The problem though I see is that if the barn door is broken, just by putting a few paint—coats of paint on it, you don't fix the door. I think we still have a broken door here, and I would hope that you would recommend to the President that he would follow the model really of Ronald Reagan in having both truly an independent Commission, in fact, as well as in perception. And I think the way to do that at this point is to take any or all of the current members, have them appointed as a Presidential Commission, add to those members an equal number of additional members that have expertise, give them their own budget, and have them report to both the President and to Congress. And

I would hope that that again, in an effort to get this truly independent Commission both in fact, as well as perception that you would make that recommendation. Thank you, Mr. Chairman.

Mr. HALL. I yield back my time, Mr. Chairman.

Chairman BOEHLERT. Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you very much, Mr. Chairman. And yesterday when we met with Admiral Gehman, I couldn't help but get a sinking feeling in my stomach when we saw this flight coming down of the shuttle and the Admiral mentioned to us that the *Columbia* had actually gone through 75 percent of what it had to go through in reentry. It had already—it was almost all the way home, and it didn't quite make it. And they had already gone through the hottest part of the reentry; they had already gone through 75 percent of the time—of danger time of reentry, and then we lost them right there at the minute.

They—we lost our astronauts, but we have a second chance now to do something to make sure that we put NASA on the right track, and to make sure that these lives were not lost in vain. And I think it is all up to all of us to take this very seriously, not just looking into what may or may not have happened, a mistake or technical problem with the Shuttle, but what we have to do with NASA to make sure it meets its potential in the future.

And the Shuttle, when it was first designed 30 years ago, it was an engineering marvel; but that was 30 years ago. And it is up to us now, as a priority, to find a cheaper and perhaps a safer way of getting into space, to make sure that America remains the number one space power on the planet. And I am looking forward to working with all of you on both sides of this aisle, and with you Mr. O'Keefe, to try to come down to exactly what we have—what happened with the Space Shuttle *Columbia,* but also in trying to make sure we move forward and put America where we want to put it.

And one note, in order to do this we really have to be very, very cautious with our numbers, and that is what we are talking about today, the budget. And Mr. Hall brought up a point that I thought was important about different plans in the past, with Europa for example, which was a very expensive space endeavor. I noticed in the budget, and I mentioned this to you before that it seemed to be a rather expensive project going to the ice moon of Jupiter; and I noticed in the budget it is a three billion dollar project, but that is only for the first five years, and it is not scheduled to go off for another 11 years. And I would wonder how much more money we are going to spend on that project. So when every dollar counts and peoples' lives are at stake, we are going to have to ask some of the tough questions today, and I appreciate Ralph for bringing up the issue and some of the other issues that Bart Gordon will also bring up as well. This is a bipartisan Committee, and thank you, Mr. Chairman, for giving me my say.

Chairman BOEHLERT. Thank you very much, Mr. Rohrabacher, and I couldn't agree more with you that we have to learn from the past as we plan for the future. And Mr. Gordon has observed, and Mr. Hall also, we have been working on a bipartisan basis to assure that the *Columbia* Accident Investigation Board is independent, in fact, not just in name. And one of the most comforting

comments I received yesterday in my rather lengthy meeting with Admiral Gehman was that, and I quote him exactly, "The Board is completely independent and will remain that way." And I think that is very important, and I am glad that the Board will be expanded.

I also was pleased by the Admiral's response to my question, who do you work for, Admiral? And he said, we work for several people. We work for the White House. We work for the Congress. We work for NASA. We work for the American people, but most of all, we are working for the families of the *Columbia* astronauts. That was the type of answer I was hoping for.

[The prepared statement of Mr. Smith follows:]

PREPARED STATEMENT OF REPRESENTATIVE NICK SMITH

I want to thank Chairman Boehlert and Ranking Minority Member Hall for holding this hearing this morning to review the fiscal year 2004 budget for NASA. I am hopeful that this hearing will provide us an opportunity to discuss not only funding, but the general direction of NASA in light of recent events.

Over the years, our country's space program has contributed greatly to our national sense of identity. From the pride and awe that we felt when Neil Armstrong took his first steps on the moon to the overwhelming collective sense of relief that we experienced when the crew of Apollo 13 made it back to earth safely. From the excitement generated by the wealth of scientific discovery that has resulted from space exploration, to the deep sadness that we felt in 1967, when Apollo 1 exploded on the launch pad, in 1986, when the Space Shuttle *Challenger* was lost shortly after takeoff, and again earlier this month, when the Space Shuttle*Columbia* broke up during the final stages of re-entry into the Earth's atmosphere.

Unfortunately, it has taken a tragedy to focus needed scrutiny on the state of our country's space program. Americans want to know how the*Columbia* accident happened, but they also demand to know the cost-benefit of manned space flight. As we consider funding levels for NASA programs, it is important that this committee closely examine policies most likely to benefit NASA in the future. I hope that this committee will not shy away from its responsibility to analyze and make needed changes.

As Chairman of the Research Subcommittee, I have often questioned witnesses on the justification for manned space flight because I am concerned that the costs are high and the benefits too few compared to unmanned flight or ground simulation. With limited dollars for research in tight budgetary times, it is imperative that Congress direct funding toward investments that give us the greatest scientific return.

The *Washington Post* has reported that the International Space Station, if completed, is expected to cost $17 billion over budget. In addition, the three person crew spends a majority of their time simply doing maintenance as opposed to doing actual research. At this time of war and tight budgets in the U.S. and other contributing countries the cost of the space station is extravagant.

While manned shuttles do provide us with some useful scientific information, it has been reported that the major objective of many missions is simply to re-supply the space station.

In contrast, unmanned space missions have provided us with extremely useful and interesting information, and at a much lower cost. For instance, according to the "Bulletin of the Atomic Scientists," the Galileo project, which discovered possible oceans on Callisto and analyzed oceans on Europa cost $1.35 billion. The Mars Pathfinder mission, which cost $270 million, provided our scientists with more than 16,000 images from Mars, 15 chemical analyses of rocks, and large amounts of useful information on Martian winds and weather. The Kepler space telescope, which will cost estimated $286 million and is expected to be operational by 2006, will be able to observe nearly 100,000 stars and any planets in orbit around them. This will allow us to estimate how many earth-like planets capable of sustaining life exist in the universe.

The NASA budget request for fiscal year 2004 offers exciting possibilities for enhancing science and science research. Proposed projects to develop a propulsion system that would allow a satellite to explore Jupiter's moons, develop high speed "Optical" communications capabilities and study the very structure of our universe are promising examples of the value and usefulness of unmanned space exploration. In addition, I applaud the proposed 6.3 percent increase in funding for NASA education

programs. As Chairman of the Subcommittee on Research, I understand how important it is to improve the math and science education in this country, from a scientific perspective but also to ensure that Americans have the technical skills to compete in an increasingly globalized economy.

It is important that this committee do everything in its power to prevent another tragedy like the loss of Columbia. The American people deserve a safe, efficient space program that maximizes scientific research and eliminates wasteful spending. As we begin developing NASA's budget, I urge my colleagues to consider all of the options that they have available to them in addressing the challenges facing our nation's space program. I welcome Administrator O'Keefe here today and I look forward to a productive discussion.

[The prepared statement of Mr. Sullivan follows:]

PREPARED STATEMENT OF REPRESENTATIVE JOHN SULLIVAN

Thank you Mr. Chairman, I appreciate your calling this hearing to consider NASA's FY 2004 budget request. As a Member of the Space and Aeronautics Subcommittee on the House Science Committee, I consider it an honor to be a part of this hearing and I appreciate Mr. O'Keefe coming here to testify today.

Today, we will be considering the $15.5 billion dollar budget request for NASA funding for FY 2004. Many questions regarding the proposed NASA budget will come up, in regard to the future of human space flight. With our Space Shuttle fleet currently grounded, we must look for ways to continue manned exploration of space, while looking at the budgetary issues facing NASA and this Congress.

This hearing is undoubtedly one of many that will determine the mission of NASA and their aeronautic and scientific priorities. Many funding questions will arise concerning the future of the Space Shuttle, the development of the Orbital Space Plane as a replacement vehicle for the shuttle and our future role of the future International Space Station. We will need to address these important funding issues in a bipartisan manner to ensure that full consideration is given to NASA's request, while looking forward to anticipate our future scientific and aeronautic goals.

[The prepared statement of Mr. Forbes follows:]

PREPARED STATEMENT OF REPRESENTATIVE J. RANDY FORBES

Thank you Chairman Boehlert, and Ranking Member Hall, for holding this important hearing today. And, I thank the witnesses for appearing before the Committee this morning as well.

Earlier this month the President presented his budget to Congress for the fiscal year 2004. While the President proposed a modest increase in NASA funding for next year, his budget also proposes to reduce the level of aeronautics R&D investment at NASA by 4.5 percent over the next five years. I am concerned that continual erosion of funding for Civil Aeronautics Research & Development will leave NASA unable to fulfill its mission and aeronautics vision.

I must also voice my concern for the impact these cuts will have on NASA's Langley Research Center in Hampton, VA. While the Langley Research Center is just outside my district, the facility does employees many of my constituents.

NASA's Langley Research Center was established in 1917 as the Nation's first civilian aeronautics laboratory. Today, 70 percent of its work is in aeronautics research, focusing on ways to improve current aircraft and develop concepts for future aircraft. I regard the work of the facility and its employees to be invaluable in forging new frontiers in aviation and space research. Langley's contributions to aerospace, atmospheric sciences, and technology commercialization are improving the way the world lives. Its research has a significant impact on the global economy, making the skies safer, quieter and more efficient.

We need to reinvest in NASA aeronautics. Twenty-five years ago, the U.S. had over 90 percent of the world market for commercial aircraft sales. Ten years ago the U.S. share of that market dropped to 70 percent. Today our market share is 50 percent. When will this stop?

Taking advantage of these trends, in January of 2001, the European Union unveiled its plan for gaining a dominant position in the global aerospace market entitled, *European Aeronautics: A Vision for 2020.* This plan lays out an ambitious $93 billion, 20-year agenda for winning global leadership in aeronautics and aviation, further endangering the lead the U.S. had maintained in one of its most prized economic sectors.

Aeronautics research is vital to our national defense. Every military aircraft design the U.S. military currently flies incorporates advanced technology developed at

NASA Research Centers. With continuing cuts to aeronautics we are losing experienced NASA engineers and discouraging young engineers from entering this field which only harms our national expertise in cutting edge aviation systems. Let's hope that the day never comes when American pilots will have to fly French planes into combat.

That is why Congressman Larson and I have introduced the Aeronautics Research and Development Revitalization Act, H.R. 586. This legislation will allow the United States to meet the European R&D challenge by increasing our role as leader in aeronautics and aviation. Our bill will provide funding for NASA to implement the objectives of their "Aeronautics Blueprint," and develop a new 21st century air transportation system for the Nation. NASA's "Aeronautics Blueprint" is useless without the funding to match.

I fully understand and recognize that many of our priorities have shifted since the terrorist attacks of September 11th, and that our economy has slowed down—resulting in lower revenues to the Federal Government. We should not, however, ask aerospace to bear the brunt of this short fall. If we were to do so, we would be killing the goose that lays a golden egg.

I look forward to working with the President and Administrator O'Keefe to see that the aerospace research receives the funding it so richly deserves.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Good morning. I want to thank Administrator O'Keefe for appearing before our committee to discuss the President's FY04 Budget for NASA. Today's hearing serves as an opportunity for oversight of certain departmental programs. On February 1, 2003, the tragic accident that destroyed the Space Shuttle *Columbia,* killing the seven astronauts aboard, dramatically changed NASA's current plans for research and development in FY 2004 and beyond. Before we move forward on NASA's budget, Congress needs to determine the future policy priorities of NASA, especially in light of the *Columbia* tragedy. I believe NASA needs to adequately fund its existing activities before embarking on expensive new initiatives. The budget for NASA leaves many significant questions unanswered and Congress needs more specifics as we consider the FY04 budget request for NASA.

NASA continues to be our gateway to the universe. It is through NASA's efforts that we will understand our planet, our solar system and beyond. NASA's budget should reflect a strong commitment to and emphasis on continuing to build the agency's core foundation of aeronautics and aerospace research and development as well as its missions of exploration and discovery to educate and inspire. However, I was disappointed to see serious reductions in the aeronautics and FAA research and development programs. NASA and FAA's investments in aeronautics research and development are dwindling at a time when many are calling for increased investment and collaboration.

I was pleased to see the NASA education budget increased by 6.3 percent over the FY 2003 request for education programs designed to encourage students of all ages to pursue math and science education. Investing in our children's math and science education will hopefully better student performance, interest, and training in the science, math, technology, and engineering fields.

I welcome our witness and look forward to his testimony.

Chairman BOEHLERT. Mr. O'Keefe, let me say to you that I am very favorably impressed, we are with the manner in which you and the NASA Family have been so open with the American people in sharing information about this tragic day in the lives of our nation and indeed the world. We are all with you and working with you to assure that the job you have is made as easy as possible as we go forward together for a better day. With that, Administrator O'Keefe.

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

Mr. O'KEEFE. Good morning, thank you, Mr. Chairman, and Congressman Hall, Members of the Committee—sorry about that. Activated here, sorry. Good morning, Mr. Chairman, and thank you

again for your very thoughtful statement to you and Congressman Hall, and to the other Members of the Committee.

I appreciate the opportunity to appear before the Committee today to discuss the President's fiscal year 2004 budget proposal of 15 and a half billion for NASA. The President's request demonstrates the Administrations continued confidence in NASA's ability to advance the Nation's science and technology agenda.

Let me first turn to a brief update, if you would, sir, on the *Columbia* accident investigation process that is underway at present. As you have all mentioned, the opportunity—I have spent time with Admiral Gehman yesterday. He has briefed several members of the Committee, and again, I might add nothing further to the commentary to that, which has been very thoughtfully presented in the opening statements by so many members here, other than to add that we are committed to letting the facts and the evidence guide the deliberations. We are cooperating fully with the *Columbia* Accident Investigation Board. Admiral Gehman and I have agreed that there is absolutely no limit to the resource capabilities and issues that we have available to the Agency or to the Federal Government for the purposes of finding the truth and determining exactly what happened in this horrific accident. In that regard, he has noted to me on several occasions, and I am gratified to hear that he expressed that as well to Members of the Committee here that the professionalism and openness that each Member of the NASA Family have demonstrated, in this case, is in pursuit of those facts, that evidence, and the truth of what happened.

It is imperative we know the truth to determine what happened because we owe that to the families, positively. We owe that to the American people who have entrusted this very important portfolio of exploration and discovery to us. And we owe it to our international partners who have participated so impressively, I think, in development of the International Space Station over the course of many years.

We have also, and understand that there are a range of issues that we have to continue to work to make the corrections once the *Columbia* Accident Investigation Board completes its deliberation, to complete corrections, and return to safe flight. That there is in this interim period for however long that lasts, a requirement to continue to support the International Space Station.

We have worked with our international partners; the 16 nations that were all combined with to develop this impressive capability of a laboratory and research capacity in space. And we have worked together to determine what that interim solution should be. And as you mentioned, Mr. Chairman, as of yesterday, we were able to reach a very specific set of conclusions on that approach. That our deliberations have been very constructive, and all the partners are acting like partners in the development of a partnership solution.

So as of yesterday, the final—or determination at this point in terms of how we proceed ahead, is we have agreed to use the Russian Emergency Egress Spacecraft that are rotated twice a year to International Space Station, to rotate the crew—the expedition crews aboard the International Space Station for this interim period.

So the next flight that will be going up in April—the end of April or early part of May, depending on the timing here, will be to bring back the current three members of the crew, Ken Bowersox, Don Pettit, and Nikolai Budarin, at that time and to bring up the crew of an Expedition 7 of two members, a US Astronaut and a Russian Cosmonaut. Those crew members have been named and they are training now in Star City, Russia, to maintain their proficiency on the Soyuz craft, and they are continuing the operations—training and other operational preparations to continue the permanent presence aboard the International Space Station.

We have also established a manifest for the flights of the Soyuz spacecraft over the course of the next year. There will be another flight in October as had been planned, to rotate that emergency egress capacity that is permanently fixed to the International Space Station. And we have agreed to accelerate the flights of the Progress autonomous un—you know, not manned vehicles that bring up logistics, water, supplies, consumables to the International Space Station, as well as spares and other requirements that are aboard for continued operation of the International Space Station.

We have agreed to a specific procedure to manifest only those mandatory elements which are required in order to maintain station as well as continue a science and research objectives to the extent possible, given the space limitations on Progress vehicles as well as on the Soyuz.

At a minimum we have also agreed that an additional two Progress vehicles, one in 2003 and one in 2004 will be accelerated in order to support at least for the next—for the foreseeable future, a capacity to support the International Space Station, at least for the next 18 months.

It will, again, be a rotation of crews at the intervals in which the Soyuz vehicles are launched, which will occur again in October, and then again six months thereafter, as has always been planned for the rotation of that capacity.

So the partnership has agreed to that. We are all in agreement on the approach on how we will proceed from this state in order to maintain that capacity and to assure that we can operationally continue this important laboratory condition.

Let me turn if you would, Mr. Chairman, to just a couple of highlights on the budget, and the topic of discussion primarily here for today. The budget I would hope we will present and be convincing of is a responsible position of our highest priorities. It is credible; it builds in reserves for technically challenging programs, and fully accounts for program costs. We believe its compelling in that it enables new initiatives to tie to our strategic objectives which are contained and delivered as part of our strategic plan. The Law requires that the strategic plan be produced in the fall. We have accelerated that and released it as part of this budget in February.

It advances our mission goals through a stepping stone approach to future exploration objectives and provides transformational technologies and capabilities that will open new pathways. And the proposal is about a new strategic direction for NASA that we have developed over the course of the last nine months, and how we plan

to shift resources toward longer-term goals outlined in the mission statement and the strategic plan therein.

Just to quickly highlight. The budget contains a nine specific initiatives, tied to mission goals that build on the strategic investments that were started as part of the fiscal year 2003 budget that Congress just enacted a week ago.

They are, first, Project Prometheus, which is to develop and demonstrate a breakthrough propulsion and power generation systems capability that will be at least a factor of 100 times greater than what we have been operating under since the beginning of our programs. The plan is to demonstrate that technology in the outyears, and again that is a proposition that we certainly will debate today and discuss. To fuel a specific ambitious objective as Congressman Rohrabacher mentioned in his opening statement toward a capacity to demonstrate on-orbit—multiple on-orbit passes rather than one flyby, which has been our typical approach we have been restricted to, given our limitations of power generation and propulsion capabilities we currently deal with.

It also includes a human research initiative to expand biomedical research and technology development to enable safe, warm duration missions on the International Space Station, as well as potential missions beyond low Earth orbit. And potential medical benefits for millions here on Earth.

It includes a optical communications initiative, investment in revolutionary laser communications technology to demonstrate on a mission by transmission—transmitting large volumes of scientific information. This is akin to moving from the telegraph to a telephone in our approach in our communications from space.

A Beyond Einstein initiative which develops to Einstein observatories, LISA, a deep space gravity-wave detector, and a Constellation-X and mission probing of what happens to matter at the edge of the black hole. Initiation of three probes designed to adjust key questions that Einstein left us. What powered the big bang? How did black holes form and grow and what is the mysterious energy pulling the universe apart at the present.

It also funds a climate change research initiative, which accelerates research to reduce key scientific uncertainties and support the President's objectives to establish a climate change research objective to inform what policy alternatives we may then follow based on that information.

We have also included an aviation security initiative to expand research to develop technologies to reduce the homeland security vulnerability of aviation to terrorist and criminal attacks.

The National Airspace System Transformation Augmentation which accelerates the development of technology to address efficiency, capacity, and security needs for air travel.

A quiet aircraft technology to continue work on technologies to significantly reduce community noise impact and achieve significant savings in amelioration programs in local communities.

And, an important education initiative that supports the new enterprise function that we have just created at NASA to fund the educator astronaut program, the explorer schools, explorer institutes, and a scholarship for service program, which is part of the

Chairman's reference to the Human Resources legislative initiative that he has referred to as well.

There—also a continuing efforts to currently fund and enable us to achieve the core configuration of the International Space Station upon return of safe flight of the Space Shuttle Program. Accommodate the international partner elements which have been produced, and our preparing for delivery to the Kennedy Space Center so we may launch them upon return to safe flight. Maintain progress on research priorities and continue to build the International Space Station to whatever the science and research objectives guide us to.

It also authorizes the establishment of a non-governmental organization like the Hubble Telescope Program that we employ for the development and prioritization of International Space Station research and science objectives.

In Integrated Space Transportation Plan which has been delivered as part of the President's Amendment to the fiscal year 2003 budget back in November, which we appreciate the Congresses endorsement of, and it continues that in 2004 to make investments in extended Shuttle operational life, new Orbital Space Plane for crew transfer capability to station, and next generation launch vehicle technologies for propulsion structures and operations.

We are submitting to Congress, again, the strategic plan, which again is developed now and has been released as part of this budget as opposed to waiting until the deliberations are concluded in the fall, which has been the typical approach which has been taken under the terms of the Government Performance Results Act, and instead released it now as part of this particular effort. An integrated budget and performance document, and performance and accountability report.

These documents reflect the Agency's improvement in areas specifically related to the budget, focusing on mission driven activities that deliver end products with enterprises and capabilities rather than by program elements.

Also, the budget is structured in 18 goal oriented themes, which are very clearly laid out as an approach to deal with our objectives.

A full cost and management function is contained in this particular approach so that every time you look at any program or initiative, that the full amount that we believe is necessary based on our best cost estimates is reflected in the cost that we present. It allocates all costs by program areas, incorporating institutional activities in program funding accounting.

An integrated budget and performance document, which informs the Congress of promised costs or estimate, schedule, and technical parameters of approved projects, and merges the budget with the performance plan, so that there is a direct relationship between the two.

And finally, it includes an Integrated Financial Management System. For the first time this year, NASA will be on one accounting system for the entire program, across all field centers. And it is being implemented and will be operational fully by June; we are halfway home right now. This is the first time in the Agency's history where we have achieved that objective.

Lastly, on the financial front, we have gone with almost no notice—we received a clean opinion from our outside auditors, which

was released as part of this budget effort as well. And that is the first time that has occurred in quite sometime as well.

And finally, Mr. Chairman, I do want to again commend you and thank you again for your personal sponsorship of the Human Resources initiatives, new tools that have in order to address the really looming issues we are going to confront on personnel, and continuing the competency and extraordinary expertise we enjoy around this Agency with new tools that we have requested from Congress. We presented a proposal that the President submitted as a Legislative Initiative last June.

Mr. Chairman, I appreciate the fact that you have held hearings on that particular point. We look forward to enactment of those proposals at the earliest opportunity, and gratified that you are—of your sponsorship for an effort to continue that cause.

Finally, again, this is, we believe, a responsible, credible, and compelling position we have taken here that is linked to the—a strategic plan that has performance goals and is an objective approach as to how to proceed with the mission areas of understanding and protecting the home planet, exploring the universe and searching for life, and inspiring that next generation of explorers, our mission goals. Thank you, Mr. Chairman, I appreciate this opportunity.

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

PREPARED STATEMENT OF SEAN O'KEEFE

Mr. Chairman and Members of the Committee, I appreciate the opportunity to appear before the Committee today to discuss the President's FY 2004 budget proposal of $15.47 billion for NASA. The President's request demonstrates the Administration's continued confidence in NASA's ability to advance the Nation's science and technology agenda.

We come together to discuss NASA's space research and exploration agenda, and our efforts to advance aviation safety and efficiency in this Centennial of Flight year, still mourning the tragic loss of the courageous crew of the Space Shuttle *Columbia.* Before I discuss the details of the budget, I would like to provide the Committee an update about the on-going investigation.

Today, 26 days after the tragic loss of *Columbia,* our work continues to honor the solemn pledge we've made to the families of the astronauts and to the American people that we will determine what caused the loss of *Columbia* and its crew, correct what problems we find, and safely continue with the important work in space that motivated the *Columbia* astronauts and inspires millions throughout the world.

Since I last appeared at the joint hearing between this committee and the Senate Commerce Committee on February 12, the independent *Columbia* Accident Investigation Board under Admiral Gehman has made significant progress in organizing its work to determine the cause of the accident. NASA has kept its pledge to fully cooperate with the work of the Board, and has taken the necessary steps to ensure the Board's complete independence.

Recovery operations, which began as soon as it became clear that *Columbia* was lost, continue on the ground in places along the Shuttle's re-entry path, stretching from San Francisco, California to Lafayette, Louisiana, where we hope to recover more vital debris from the accident. We continue to send everything we find to the Kennedy Space Center in Florida for assembly and analysis as part of the *Columbia* Accident Investigation Board's comprehensive accident investigation.

The careful search for debris will continue in the weeks ahead, with our best opportunity to find remaining debris occurring in the next few weeks before the spring growing season begins. As I stated during the joint committee hearing on February 12, NASA is deeply grateful for the support we have received during recovery operations from more than 2000 men and women from the Department of Homeland Security, Federal Emergency Management Agency, Environmental Protection Agency, Federal Bureau of Investigation, Department of Defense, Department of Transportation, U.S. Forest Service, U.S. Park Service, Texas and Louisiana National Guard,

and state and local authorities who have helped us locate, document, and collect debris.

Implications of Suspension of Shuttle Flights

Mr. Chairman, you specifically requested that I address the implications of suspension of Shuttle flight for other programs, including the International Space Station (ISS), Hubble Space Telescope, and plans for the Orbital Space Plane Program. You also asked that I address near- and long-term contingency planning for the ISS. I will provide a brief summary, and am prepared to discuss the status with you in detail today, and in the weeks and months ahead.

With respect to the ISS, the Expedition 6 Crew—Commander Ken Bowersox, Science Officer Donald Pettit and Cosmonaut Flight Engineer Nikolai Budarin—continue to perform science while performing routine ISS maintenance on orbit. There are no threats to the ISS or its crew in the near-term, and we are working options to be able to sustain both over the long-term. All remaining U.S. manufactured ISS hardware for the Core Complete configuration has been delivered to KSC and element ground processing is on schedule. Delivery of Node 2, built for NASA by the European Space Agency, is on schedule for April 2003. Ground processing will continue until ready for Shuttle integration. Only one ISS mission, STS–118, in the critical path to U.S. Core Complete was manifested on *Columbia.* The primary mission objective of STS–118 is the transfer and installation of the S5 Integrated Truss assembly to the S4 Truss. While the manifest for the remaining three Orbiters will need to be adjusted to accommodate this flight, all other previously scheduled ISS assembly missions will be flown in their original order. A revised U.S. Core Complete assembly schedule will be confirmed when the Shuttle is ready to return to flight status.

With respect to the Hubble Space Telescope (HST), NASA can continue to service it, and any Orbiter is capable of supporting HST servicing missions. Furthermore, the HST is performing well, and is a robust observatory in no immediate need of servicing. Should a delay in the planned servicing mission (November 2004) occur that impacts the Telescope's ability to perform its science mission, HST can be placed in safe mode until a servicing mission can be arranged.

With respect to the Orbital Space Plane Program (OSPP), I am pleased to report that NASA recently released the OSPP Level One Requirements. The OSPP Mission Needs Statement directs that the OSPP vehicle(s) and associated systems shall support U.S. ISS requirements for crew rescue, crew transport, and some cargo. The requirements mandate that the system, which may include multiple vehicles, shall provide rescue capability for no fewer than four ISS crew *as soon as practical* but no later than 2010. The requirements also state that the system shall provide transportation capability for no fewer than four crew to and from the ISS *as soon as practical* but no later than 2012. These requirements, drafted prior to the loss of *Columbia,* already reflect schedule urgency. Immediately following the *Columbia* tragedy, an inter-Center team was convened to consider options to responsibly accelerate the program while still addressing NASA's requirements.

In the absence of Space Shuttle support, NASA is addressing contingency requirements for the ISS for the near- and long-term. As I said earlier, there is no immediate danger to the Expedition 6 Crew. In order to keep the crew safe, however, we must ensure that they have sufficient consumables, that the ISS can support the crew, and that there is a method for crew return available. Working closely with our international partners, we have confirmed that there is sufficient propellant onboard the ISS to maintain nominal operations through the end of this year. With the docking of the Progress re-supply spacecraft on February 4 (ISS Flight 10P), the crew has sufficient supplies to remain on the ISS through June without additional re-supply. As we move beyond June, however, potable water availability becomes the constraining commodity. We are currently working closely with our Russian partner, Rosaviakosmos, to explore how best to address this issue on future near-term ISS re-supply missions. A Soyuz spacecraft (ISS Flight 5S) is docked to the ISS and serves as a rescue vehicle for crew return in the event of a contingency. These Soyuz spacecraft have an on-orbit lifetime limitation of approximately 200–210 days, and must be replaced periodically. The Soyuz 5S vehicle will reach its lifetime limit in late April/early May, and will need to be returned.

We are currently evaluating strategies with our International Partners to keep the ISS crewed and supplied with sufficient consumables, and to replace the Expedition 6 Crew. The ISS Partnership is committed to maintaining crew on-orbit. To address the near-term anticipated shortfall in potable water, one of the strategies that NASA and its partners are considering is bringing up a new crew of two (one U.S. and one Russian) on the next Soyuz spacecraft (ISS Flight 6S), scheduled for launch in late April. to replace the Expedition 6 Crew of three. We are also working closely

with Rosaviakosmos to evaluate the flexibility and constraints of the Progress flight schedule to support the crew.

In the unlikely event that de-crewing is required, the ISS can be configured and de-crewed using established contingency procedures. The ISS can remain without a crew for an extended period of time while maintaining altitude with Progress and onboard re-boost capability, without crew interaction. NASA will continue to meet its commitments to our ISS International Partners. Once we understand what caused the *Columbia* accident and can return to flight, we will resume assembly of the ISS.

The ISS, now in its third year of human occupancy, represents an important milestone in history. Due to this capability, humans are now able to permanently occupy the realm outside of Earth and are actively conducting ambitious research spanning such scientific disciplines as human physiology, genetics, materials science, Earth observation, physics, and biotechnology.

FY 2004 Budget Request

On that sunny Saturday morning, February 1st, as I awaited the landing of the *Columbia,* I was contemplating my return to Washington, D.C., to prepare for the release of NASA's FY 2004 budget. We had worked aggressively over the past year to develop a new Strategic Plan and fashion a budget to make it a reality. I was excited about announcing these plans with the release of the President's FY 2004 Budget in two days. I had no idea how that tragic morning would change my focus over these ensuing weeks. During the days that followed, I was asked by some whether the *Columbia* accident would force us to toss aside our budget and long-range plans. Mr. Chairman, I will tell you as I told them, I think not. A test of any long-tern plan is whether it can accept the inevitable setbacks and still achieve its goals. That is my hope for our plan.

Mr. Chairman, in light of the recent tragic loss of *Columbia,* we must recognize that all exploration entails risks. In this, the Centennial Year of Flight, I am reminded of an accident that occurred just across the river at Ft. Myer in 1908 onboard the Wright flyer. The Wright brothers were demonstrating their flying machine to the U.S. Army, and a young lieutenant was riding as an observer. The flyer crashed, and Lt. Thomas Selfridge died of head injuries, thus becoming the first fatality of powered flight. From that accident in 1908 came the use of the crash helmet. So too from *Columbia* we will learn and make human space flight safer.

Although the budget proposal was prepared prior to the loss of *Columbia* and its crew, I am convinced that NASA's FY 2004 budget proposal is responsible, credible, and compelling. It is *responsible* by malting sure that our highest priorities are funded; it is *credible* by ensuring that adequate budget is built into the most technically challenging programs, and that we will fully account for the costs of all our programs; and, it is *compelling* by allowing NASA to pursue exciting new initiatives that are aligned with our strategic objectives. As I mentioned previously, the President's FY 2004 budget request for NASA is $15.47 billion. While I will not rule out potential adjustments to this proposal that may be appropriate upon completion of the independent Gehman Board investigation, I look forward to discussing the FY 2004 budget request and how it advances our mission goals of understanding and protecting the home planet, exploring the Universe and searching for life, and inspiring the next generation of explorers, and, in so doing, honoring the legacy of the *Columbia* astronauts.

Establishing Our Blueprint

Today's discussion is about more than changes in the budget—which is usually just a discussion over how one might change a few percent of one's budget from the year to year—but instead it is about a new strategic direction for NASA and how we are planning to shift our resources toward our longer-term goals. In April 2002, I gave a speech at the Syracuse University that espoused a new Vision and Mission for NASA. There are only 13 words in NASA's Vision and 26 words in NASA's Mission, but every word is the product of extensive senior leadership debate within NASA. And what you see in our new Strategic Plan is the product of those discussions, and the product that the entire NASA team is committed to delivering for the American people. Indeed, we did not need to release this Strategic Plan with our budget—after all, the law stipulates September 2003—but we felt that if we are serious about our Vision and Mission, we must have it during our budget deliberations and release it simultaneous with our budget.

NASA's strategy for the future represents a new paradigm. In the past, we achieved the marvel of the moon landing, an incredible achievement that has shaped much of NASA today, driven by a great external event—the Cold War—that allowed our nation's treasury to be aggressively spent on such a goal. Today, and

in the decades since Apollo, NASA has had no comparable great external imperative. This, however, does not mean that we cannot lift our eyes toward lofty goals and move up the ladder—using the *stepping stones* we have identified. We believe that we can make great strides in our exploration goals—not on some fixed timescale and fixed location—but throughout our solar system with ever more capable robotic spacecraft and humans to enable scientific discovery. Hence, we will not be driven by timeline, but by science, exploration, and discovery. We will pursue *building blocks* that provide the transformational technologies and capabilities that will open new pathways. We can do this within our means. And if someday there is an imperative or new discovery that pushes us further, we will be ready and well along the way.

To be successful, we will transform ourselves as follows:

- All investments will contribute to our goals and traceable to the Vision and Mission. Every NASA program and project must be relevant to one or more of the goals, and perform successfully against measures.
- Human space flight capabilities will be enhanced to enable research and discovery. We will continue to expand human presence in space—not as an end in itself, but as a means to further the goals of exploration, research, and discovery.
- Technology developments will be crosscutting. We will emphasize technologies with broad applications, such as propulsion, power, computation, communications, and information technologies.
- Education and inspiration will be an integral part of all our programs. We will track performance of our education programs like that of any other NASA activity.
- We will operate as One NASA in pursuit of our Vision and Mission. We will reinforce the shared commitment of all NASA employees to our common goals.
- As Only NASA Can: We will pursue activities unique to our Mission—if NASA does not do them, they will not get done—if others are doing them, we should question why NASA is involved.

Strengthening Our Foundation

This building block and stepping stone approach already has one important brick in place: the FY 2003 Omnibus Appropriations Act, signed by the President on February 20. The FY 2003 appropriation contains many of the needed elements that will help NASA address important constraints in power, transportation, and human capabilities. The FY 2003 budget contains funding for NASA's:

- *Nuclear Systems Initiative* to develop new power and propulsion technologies that will enable solar system exploration missions that are inconceivable with current conventional chemical propulsion systems. This initiative has been incorporated in *Project Prometheus* as part of our FY 2004 Budget request.
- *International Space Station (ISS),* including full funding to assure we can successfully reach the milestone of U.S. Core Complete—which will enable accommodation of International Partner elements—maintain progress on long-lead items for enhanced research, and continue to build out this research laboratory platform for overcoming human limitations in space. It also includes authority to proceed with establishment of a Non-Governmental Organization (NGO) for ISS research. This funding and authority builds on our major achievements over the past year. We have received endorsements by two independent cost teams that deemed the program's cost estimates as "credible" and the ISS Management and Cost Evaluation (IMCE) independent task force, chaired by Tom Young, that commended our progress against their recommended management reforms. We have revamped our science program towards the highest priority research as identified by the Research Maximization and Prioritization (ReMAP) independent task force. We have put in place a new management team to control program content, ensure science requirements are met, and refocus program from development to operations. Finally, we are implementing new financial management tools to better manage our resources.
- *Integrated Space Transportation Plan (ISTP)* that will address our nation's near- and mid-term requirements in human space flight by making investments to extend the Shuttle's operational life for continued safe operations; developing a new Orbital Space Plane to provide a crew transfer capability as early as possible to assure access to and from the International Space Sta-

tion; and, funding next-generation launch vehicle technology in such areas as propulsion, structures, and operations. Since providing our ISTP as part of the FY 2003 budget amendment in November 2002, we have moved out aggressively on this roadmap. We are refining the Shuttle's Service Life Extension Program to better identify priorities and long-term investments. We also have completed top-level requirements for the Orbital Space Plane and awarded contracts to address priority technologies and areas of risk. Finally, we are refining our investments in long-term launch technologies as part of our recently initiated space architecture activities. We believe the ISTP is a good plan, but we are committed to re-examining it if necessary in light of future investigation findings on *Columbia.*

We must ensure that we have a sound foundation—our people, processes, and tools—from which to build our programs. It is only from such a sound foundation that we can go forward to more ambitious plans. We have placed the highest priority on achieving the goals of the President's Management Agenda, which contain five Government-wide initiatives that promise to significantly improve our management foundation:

- *Human Capital:* We have begun to implement our strategic human capital plan, including a tracking system to identify workforce deficiencies across the Agency. I will address this very important issue at the conclusion of my remarks.
- *Competitive Sourcing:* We have achieved the government-wide, 15 percent competitive sourcing goal, and are pursuing, wherever feasible, new opportunities for competition, including the renewal of contracts.
- *Financial Performance:* We have addressed all issues contained in the disclaimer opinion on NASA's 2001 audit and been given a clean opinion for 2002.
- *E–Government:* We are addressing information technology security issues and reviewing and enhancing other IT capabilities.
- *Budget & Performance Integration:* We are budgeting for the full cost of NASA's programs and have integrated our budget and performance plan starting with FY 2004 Budget.

Mr. Chairman, I would like to specifically highlight NASA's newest Enterprise, Education. The Education Enterprise was established in 2002, to inspire more students to pursue the study of science, technology, engineering and mathematics, and ultimately to choose careers in those disciplines or other aeronautics and space-related fields. The new Enterprise will unify the educational programs in NASA's other five enterprises and at NASA's 10 field Centers under a One NASA Education vision. NASA's Education vision will permeate and be embedded within all the Agency's activities.

Linking Investments to Strategic Plan

Simultaneously with the submission of the President's FY 2004 budget request, we submitted to the Congress the Agency's new Strategic Plan, our Integrated Budget and Performance Document, and our Performance and Accountability Report. I believe the sweeping changes we are proposing in our FY 2004 Budget represent the most ambitious in our history and will enable us to vastly improve our ability to align our investments with our goals, assess progress, and make sound economic and technical decisions based on accurate and timely information. These improvements include:

- *Budget Restructure*—In response to our new Strategic Plan, we have restructured our budget. NASA's new Strategic Plan recognizes that we are organized by those Mission-driven activities that deliver our end products—Space Science, Earth Science, Biological and Physical Research, Aeronautics, and Education—and by those activities—International Space Station, Space Shuttle, Space Flight Support, and Crosscutting Technology—that enable our Mission-driven activities to succeed. To mirror the organization of activities in our Strategic Plan into mission-driven efforts and supporting capabilities, and to recognize the reality that there is no arbitrary separation between human and science activities, the FY 2004 budget replaces the previous structure with two new appropriation accounts: *Science, Aeronautics and Exploration;* and, *Space Flight Capabilities.* For FY 2004, the request includes $7.661 billion for *Science, Aeronautics and Exploration* and $7.782 billion for *Space Flight Capabilities.*

Furthermore, the budget is structured in 18 goal-oriented *Themes,* which aggregate programs to be managed as a business portfolio in pursuit of common goals and performance measures.

- *Full Cost Accounting and Management*—In a landmark event, we have allocated all our costs by program areas. Throughout our history, NASA has treated the cost of institutional activities (personnel, facilities, and support) separate from the programs they benefit. This has made economic trades difficult to analyze. In this budget, we have placed all costs against programs so that, for the first time, we can readily determine the true total costs of programs and allow managers to make more efficient and effective choices.
- *Integrated Budget and Performance Document*—We have revamped our Congressional justification with a new document that merges our restructured budget with our performance plan. The document highlights the 18 themes and associated performance measures. Moreover, it clearly identifies projects approved for full-scale development, including promised cost, schedule, and technical parameters.
- *Integrated Financial Management System*—After a decade of trying, we are successfully bringing online a new integrated financial management system. For the first time in the agency's history, we will have one financial system for all our Field Centers, a major step in our *One NASA* goal. The core financial module will replace the legacy systems at all our Centers by this summer. This new system implementation is critical for enabling successful management of the budget, cost, performance, and the accounting changes mentioned above. Moreover, this new system will significantly enhance our ability to maintain a clean financial audit opinion.

Pursuing Critical New Opportunities

At NASA, we are developing *building blocks* that open new pathways of exploration and discovery. Today, our telescopes peer billions of years into the past to witness the beauty and unlock the mysteries of the early universe. Our satellites view the entire planet from space, allowing us to study global change and its consequences for life on Earth. Our spacecraft travel throughout the solar system and into the uncharted territories beyond, exploring the processes that have led to the incredible diversity of the planets and the emergence of life. Our aeronautics research has given people the routine ability to travel safely and reliably all around the world. Our astronauts are living and working in space, and from them, we are learning how to expand our sphere of exploration far beyond the bounds of Earth.

But, our ability to filly achieve our Mission is constrained by the need for new technologies that can overcome our current limitations. We must provide ample power for our spacecraft as well as reliable and affordable transportation into space and throughout the solar system. We must deploy innovative sensors to probe Earth, other planets, and other solar systems. We must be able to communicate large volumes of data across vast distances, so that we can get the most from our robotic explorers. And we must learn to mitigate the physiological and psychological limitations of humans to withstand the harsh environment of space.

To address these and other challenges, we must build upon the strategic investments we are making in the FY 2003 Budget and pursue critical new opportunities. Consequently, our FY 2004 Budget request includes nine new initiatives:

- *Project Prometheus* will use breakthrough nuclear propulsion and power systems to fuel an ambitious mission to Jupiter's icy moons, which astrobiologists believe could harbor organic material, and lay the groundwork for even more ambitious exploration missions in the coming decades. The FY 2004 budget request includes $93 million for this initiative, and $2.07 billion over five years.
- *Human Research Initiative* will conduct biomedical research and develop technologies to enable safe and efficient long-duration space missions, including potential future missions beyond low-Earth orbit. This initiative will provide knowledge and technology for efficient life support on the ISS, and has potential medical benefits for millions here on Earth. The FY 2004 budget request includes $39 million for this initiative, and $347 million over five years.
- *Optical Communications Initiative* will invest in revolutionary laser communications technologies that will allow planetary spacecraft to transmit large volumes of scientific information, and will be demonstrated on a Mars mission in 2009. The FY 2004 budget request includes $31 million for this initiative, and $233 million over five years.

- *Beyond Einstein Initiative* will launch two Einstein Observatories: LISA (Laser Interferometer Space Antenna), a deep-space-based gravity wave detector that will open our eyes to the as-yet-unseen cosmic gravitational radiations; and Constellation-X, a mission that will tell us what happens to matter at the edge of a black hole. In addition, the FY 2004 budget request provides funding to initiate Einstein Probes, three spacecraft that will answer: "What powered the Big Bang?" (the *Inflation* Probe); "How did black holes form and grow?" (the *Black Hole Finder* Probe); and, "What is the mysterious energy pulling the Universe apart?" (the *Dark Energy* Probe). The FY 2004 budget request includes $59 million for this initiative, and $765 million over five years.
- *Climate Change Research Initiative* is an interagency effort to accelerate research targeted at reducing key scientific uncertainties to help the Nation chart the best course forward on climate change issues. The FY 2004 budget request includes $26 million for this initiative, and $72 million over five years.
- *Aviation Security Initiative* will develop technologies to help reduce the vulnerability of aviation to terrorist and criminal attacks. The FY 2004 budget request includes $21 million for this initiative, and $225 million over five years.
- *National Airspace System Transformation Augmentation* will accelerate the development of technology to help address efficiency, capacity and security needs. The FY 2004 budget request includes $27 million for this initiative, and $100 million over five years.
- *Quiet Aircraft Technology Acceleration* will develop technology to help significantly reduce community noise impact and achieve significant savings in amelioration programs. The FY 2004 budget request includes $15 million for this initiative, and $100 million over five years.
- *Education Initiative* includes funding for NASA's Educator Astronaut Program, NASA Explorer Schools, NASA Explorer Institutes, and Scholarship for Service. The FY 2004 budget request includes $26 million for this initiative, and $130 million over five years.

While there have been additional funding provided to NASA's previous five-year budget runout to provide for these new initiatives, the balance of the funds for the initiatives has resulted from reprioritization of future funding to more appropriately pursue the Agency's Vision/Mission and goals. These initiatives will plant the seeds to enable future achievements. From them, we will continually advance the boundaries of exploration and our knowledge of our home planet and our place in the universe. We seek answers along many paths, multiplying the possibilities for major discoveries. The capabilities we develop may eventually enable humans to construct and service science platforms at waypoints in space between Earth and the Sun. Someday, we may use those same waypoints to begin our own journeys into the solar system to search for evidence of life on Mars and beyond.

Mr. Chairman, as I indicated above, there is one additional point I wish to make. I would like to briefly discuss the state of our workforce, the lifeblood of this Agency. Last year, NASA submitted to the Congress a series of legislative proposals to help the Agency reconstitute and reconfigure our workforce. These provisions, for the most part, mirrored tools contained in the President's proposed Managerial Flexibility Act, and three of them have since been enacted on a Government-wide basis in the Homeland Security Act. We have worked extensively with this committee to refine the remaining proposals, and we appreciate all the Committee's efforts to date. NASA's workforce is an aging workforce. At the time of Apollo 17, the average age of the young men and women in Mission Control was 26 years; today, we have three times as many personnel over 60 years of age as under 30 years of age. Since 1999, there have been at least 18 studies and reports concerning the workforce challenges facing NASA. Within five years, nearly 25 percent of NASA's current workforce will be eligible to retire. The potential loss of this intellectual capital is particularly significant for this cutting-edge Agency that has skills imbalances. I strongly solicit the support of the Committee to ensure expeditious enactment of this critical legislation.

Appended to my testimony, as Enclosure 1, is a chart displaying NASA's FY 2004 five-year budget request. Also appended, as Enclosure 2, is a summary of the significant progress that NASA has made in the past year on a number of important research and exploration objectives, and a detailed summary of NASA's FY 2004 budget request.

The *Columbia* accident has reminded me that we cannot stop dreaming. We cannot stop pursuing our ambitious goals. We cannot disappoint future generations when we stand at the threshold of great advances. Mr. Chairman, I believe that NASA's FY 2004 budget request is well conceived and worthy of the favorable consideration by the Committee. I am prepared to respond to your questions.

Enclosure 1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
PRESIDENT'S FY 2004 BUDGET REQUEST

(budget authority, $ in millions)	Business as Usual	FULL COST						Chapter Number
By Appropriation Account By Enterprise By Theme	Pres. Bud. FY 2003	Est. Pres. Bud. FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	
Science, Aeronautics & Exploration	7,615	7,181	7,061	8,269	8,746	9,291	9,527	SAE SUM 1
Space Science	**3,414**	**3,469**	**4,000**	**4,681**	**4,952**	**5,279**	**5,573**	SAE 1
Solar System Exploration	978	1,048	[illegible]	1,648	1,843	1,952	2,054	SAE 2
Mars Exploration	496	551	570	607	550	662	985	SAE 3
Astronomical Search for Origins	668	789	[illegible]	968	1,020	1,022	1,061	SAE 4
Structure & Evolution of the Univ.	331	398	[illegible]	418	428	475	557	SAE 5
Sun-Earth Connections	544	674	770	959	1,111	1,169	1,216	SAE 6
Institutional	370	--	--	--	--	--	--	
Earth Science	**1,628**	**1,619**	**1,913**	**1,525**	**1,588**	**1,700**	**1,725**	SAE 7
Earth System Science	1,249	1,529	1,417	1,440	1,511	1,606	1,629	SAE 8
Earth Science Applications	62	81	75	85	67	94	96	SAE 9
Institutional	318	--	--	--	--	--	--	
Biological & Physical Research	**842**	**913**	**[illegible]**	**1,043**	**1,087**	**1,118**	**1,143**	SAE 10
Biological Sciences Research	245	304	[illegible]	399	453	456	481	SAE 11
Physical Sciences Research	247	351	[illegible]	382	380	409	401	SAE 12
Commercial Research & Support	170	254	251	251	254	253	262	SAE 13
Institutional + AM + SAGE	181	3	--	--	--	--	--	
Aeronautics *	**986**	**949**	**[illegible]**	**932**	**939**	**934**	**916**	SAE 14
Aeronautics Technology	541	949	[illegible]	932	939	934	916	SAE 15
Institutional	445	--	--	--	--	--	--	
Education	**144**	**168**	**[illegible]**	**169**	**169**	**170**	**170**	SAE 16
Education	144	168	[illegible]	169	169	170	170	SAE 17
Space Flight Capabilities	7,960	7,875	7,752	7,748	7,661	8,066	8,247	SFC SUM 1
Space Flight	**6,131**	**6,107**	**[illegible]**	**6,027**	**6,053**	**6,196**	**6,401**	SFC 1
Space Station	1,492	1,651	[illegible]	1,587	1,586	1,606	1,603	SFC 2
Space Shuttle	3,208	3,786	[illegible]	4,020	4,055	4,186	4,369	SFC 3
Space Flight Support	239	471	[illegible]	419	402	407	429	SFC 4
Institutional	1,192	--	--	--	--	--	--	
Crosscutting Technologies *	**1,829**	**1,768**	**[illegible]**	**1,720**	**1,608**	**1,869**	**1,846**	SFC 5
Space Launch Initiative	879	1,190	[illegible]	1,124	1,221	1,297	1,224	SFC 6
Mission & Sci. Measurement Tech.	275	434	[illegible]	435	439	439	444	SFC 7
Innovative Tech Trans. Partnerships	147	183	[illegible]	161	168	172	179	SFC 8
Institutional	528	--	--	--	--	--	--	
Inspector General	25	25	26	28	29	30	31	IG
TOTAL	**15,600**	**15,000**	**15,489**	**16,043**	**16,056**	**17,287**	**17,806**	
year to year increase			3.1%	3.7%	3.8%	3.8%	2.9%	

* Aerospace Technology Enterprise includes both Aeronautics and Crosscutting Technologies

NOTE: May not add due to rounding

Enclosure 2

Summary

NASA Accomplishments During 2002 and FY 2004 Budget Request

NASA has made significant progress during 2002 on a number of important research and exploration objectives. During the past year, NASA:

- Captured a dramatic new portrait of the infant universe in sharp focus. NASA's Wilkinson Microwave Anistropy Probe revealed the first generation of stars that began shining only 200 million years after the big bang and forecasted the age of the universe at 13.7 billion years old. Most striking though was the probe's discovery that the universe will probably expand forever.
- Upgraded the Hubble Space Telescope on *Columbia*'s mission (STS–109) in March 2002. *Columbia*'s astronauts installed new solar panels, a better central power unit and a new camera that increased Hubble's "vision" tenfold, and revived a disabled infrared camera using an experimental cooling system.
- Celebrated Riccardo Giacconi's 2002 Nobel Prize in Physics for his pioneering NASA sponsored work in the field of X–Ray astronomy. This work has led to important discoveries about the nature of black holes, the formation of galaxies, and the life cycles of stars.
- Demonstrated a prototype device that automatically and continuously monitors the air for the presence of bacterial spores that may be used to detect biohazards, such as anthrax.
- Made progress on the development of a radar system for aircraft that detects atmospheric turbulence, thus improving prospects for commercial airliners to avoid the kind of bumpy weather most airline passengers find uncomfortable.
- Advanced technology to reduce airliner fuel tank fires or explosions, in our effort to make air travel safer and more secure.
- Began tests on a technology effort to develop lighter-weight flexible-wing aircraft.
- Measured through the Mars Odyssey spacecraft enough water ice buried deep under the poles of the red planet, that if thawed, could fill Lake Michigan twice over.
- Discovered for the first time, a planetary system, circling the nearby star 55 Cancri, with a Jupiter-sized planet at about the same distance for its parent star as our own Jupiter is from our sun. This discovery enhances the possibility that Earth-like planets could exist in such systems throughout the galaxy.
- Conducted Earth Science research that may one day allow public health officials to better track and predict the spread of West Nile Virus or similar diseases.
- Worked to develop cutting-edge technologies that will increase our weather forecasting capability from the current three-to-five-day accuracy level up to a seven-to-ten-day level within this decade.
- Observed the disintegration of the Antarctic Larsen Ice Shelf and the seasonal acceleration of the Greenland ice sheet.
- Encouraged thousands of students to learn more about space exploration through a nationwide contest to "Name the Rovers" that will launch toward Mars this year.
- Published "Touch the Universe: A NASA Braille Book of Astronomy," a book that for the first time presents for visually impaired readers color images of planets, nebulae, stars, and galaxies. Each image is embossed with lines, bumps, and other textures. The raised patterns translate colors, shapes, and other intricate details of the cosmic objects, allowing visually impaired people to feel what they cannot see.
- Celebrated a second year of continuous human habitation on the International Space Station, the largest and most sophisticated spacecraft ever built, and continued assembly with four Space Shuttle missions.

- Reflecting the Agency's increased ISS research tempo, conducted approximately 48 research and technology development experiments aboard Station, including the first materials science research aboard Station, testing medical procedures for controlling the negative effects of space flight and increasing understanding of changes to bone and the central nervous system that occur in space. Astronauts conducted advanced cell culturing research, broke new ground in the study of dynamic systems, made up of tiny particles mixed in a liquid (colloids), and installed three new Station experiment equipment racks.

FY 2004 Budget Detail

Space Science Enterprise

The Space Science Enterprise seeks to answer fundamental questions about life in the universe, including how it arose, its mechanisms, where in the solar system it may have originated or exist today, and whether there are similar planetary environments around other stars where the signature of life can be found. The Enterprise also seeks to understand how the universe began and evolved, how stars and galaxies formed, and how matter and energy are entwined on the grandest scale. The proposed FY 2004 budget for the Space Science is $4.007 billion. The five theme areas in the Space Science Enterprise are:

Solar System Exploration

We are blessed to live in a fascinating neighborhood, one that we are getting to know better every day. This theme seeks to understand how our own Solar System formed and evolved and to determine if life exists beyond Earth.

The Administration's FY 2004 budget request is $1,359 million. The budget request will support: the launch of the Deep Impact mission to probe below the surface of comet Temple-1 in January 2004; the Stardust spacecraft's January 2004 encounter with the comet Wild-2, and Stardust's return to Earth with dust samples from the comet in 2006; the March 2004 launch of the MESSENGER mission to explore Mercury, our least explored terrestrial planet; the arrival at Saturn of the Cassini spacecraft in July 2004, following a seven-year journey; and the return to Earth in September 2004 of the Genesis spacecraft with its samples of the solar wind following its two-year "sunbath." The budget also contains funding for the New Frontiers program to explore the outer planets in the Solar System and for Astrobiology research to improve our ability to find and identify potential life harboring planets.

We are very excited about two new Solar System Exploration initiatives that the budget will support. Building on the work of our Nuclear Systems Initiative, Project Prometheus is a new start to develop breakthrough power and propulsion technology that will lead to nuclear-powered spacecraft that will search early in the next decade for evidence of global subsurface oceans and possible organic material on Jupiter's three icy Galilean moons: Europa, Ganymede, and Callisto.

Such advances in nuclear power and propulsion have set the stage for the next phase of outer solar system exploration.

Following in the same progress that led from Pony Express to Telegraph to Telephone, our Optical Communications initiative will use laser light instead of radio waves to revolutionize the way our spacecraft gather and report back information as they continue to scout the Solar System. Today, using conventional radio frequency communications, the Mars Reconnaissance Orbiter will take 21 months to map 20 percent of the red planet's surface. By contrast, optical communications would allow the *entire* surface to be mapped in four months. The budget will support a demonstration of the technology in 2009 using a Mars orbiting satellite that will relay data to high-altitude Earth balloons. If successful, this technology promises to achieve dramatic reductions in the cost per byte of data returned and could ultimately replace the Deep Space Network.

Mars Exploration

The Mars Odyssey spacecraft's discovery of large quantities of water frozen beneath the Mars' polar areas provides additional tantalizing evidence that our neighboring planet had a wet and warmer past. This water and hints of relatively recent liquid water flows make Mars the most likely place to seek evidence of ancient or present extraterrestrial life. Mars is also worth studying because much can be learned comparatively between the current and past geology, atmospheres, and magnetic fields of Earth with Mars. We also hope to advance our understanding of Mars because some day in the not so distant future, human explorers may take humanity's next giant leap to the Red Planet.

The proposed Mars exploration budget is $570 million. This request will support our goal of 90 days of surface operations of the twin Mars Exploration Rovers, set to begin in January and February of 2004 at sites where ancient water once flowed.

The budget also supports the continued development of the Mars Reconnaissance Orbiter, a spacecraft that will map Martian surface features as small as a basketball in 2005; the Mars Science Laboratory, a rover that will traverse tens of kilometers over Mars in 2009 and last over a year, digging and drilling for unique samples to study in its onboard laboratory; and the telecommunications satellite that will demonstrate our laser light optical communications technology in 2009.

Astronomical Search for Origins

The astounding portrait of the infant universe captured by NASA's Wilkinson Microwave Anistropy Probe provides one more demonstration of the human capacity to probe more deeply into the mysteries of creation. This theme strives to answer two profound questions: Where did we come from? Are we alone? It does so by observing the birth of the earliest galaxies and the formation of stars, by finding planetary systems in our galactic neighborhood, including those capable of harboring life, and by learning whether life exists beyond our Solar System. One year may seem inconsequential in a Universe that is 13.7 billion years old, but as we learned during the last year, a great deal of knowledge and understanding can be obtained in the period it takes the Earth to orbit the Sun.

The Administration's proposed FY 2004 budget request for the Astronomical Search for Origins is $877 million. The budget will provide funding for: continued operations of the Hubble Space Telescope; the development of the next-generation James Webb Space Telescope and the Space

Interferometry Mission, a device scheduled for launch in 2009 that will increase our ability to detect planets around nearby stars; and initial science operations of the Space Infrared Telescope Facility, the final mission of NASA's Great Observatory Program. The budget was also designed to support the final Space Shuttle servicing mission to the Hubble Space Telescope, a mission that is now on hold pending the report of the *Columbia* Accident Investigation Board.

Structure and Evolution of the Universe

This theme seeks to understand the nature and phenomena of the Universe. It seeks to understand the fundamental laws of space, time and energy and to trace the cycles that have created the conditions for our own existence. This is accomplished in part by observing signals from the Big Bang, mapping the extreme distortions of space-time about black holes, investigating galaxies, and understanding the most energetic events in the universe. The theme also attempts to understand the mysterious dark energy that pervades the Universe and determines its ultimate destiny.

The proposed budget for this theme is $432 million, which will support development of the Gamma-ray Large Area Space Telescope, a mission to study high-energy objects like black holes.

The budget will also support a new initiative that will honor the continuing legacy of Albert Einstein, some 99 years after Einstein developed his theory of Special Relativity. The Beyond Einstein initiative will attempt to answer three questions left unanswered by Einstein's theories: What powered the Big Bang? What happens to space, time, and matter at the edge of a black hole? What is the mysterious dark energy expanding the Universe? Under the initiative, a Laser Interferometer Space Antenna will use three spacecraft "formation flying" five million kilometers apart in a triangle to observe the distortion of space due to gravity waves. Also, Constellation-X, an X-ray telescope 100 times more powerful than all existing X-ray telescopes, will use a team of powerful X-ray telescopes working in unison to observe black holes, investigate "recycled" stellar material, and search for the "missing matter" in the universe. Finally, the initiative will support Einstein Probes, a program that will begin later this decade, consisting of fully and openly competed missions (in the manner of the Discovery, Explorers, and New Frontiers programs) to conduct investigations that benefit science objectives within the theme.

Sun-Earth Connections

We should never take our life-sustaining Sun for granted. NASA's Sun-Earth Connections theme investigates our Sun and how its structure and behavior affect Earth. NASA seeks to understand how the variability of solar radiation affects Earth's climate; and how we can better predict solar flares that affect the upper atmosphere and can damage satellites and disable the power distribution grid on the ground. NASA also uses the Sun as an ideal laboratory for researching basic physics and learning how other stars function.

The proposed budget for NASA's Sun-Earth Connections theme is $770 million. The budget will support the development of the STEREO, the Solar Dynamics Observatory and future flight missions. Scheduled for a 2005 launch, STEREO will use two identically equipped spacecraft to provide revolutionary 3–D imaging of coronal mass ejections. The Solar Dynamics Observatory, which will study the Sun's magnetic field and the dynamic processes that influence space weather, will enter implementation of development in January 2004.

Earth Science Enterprise

In the near-half century that we have lived in the "space age" the most interesting planet that NASA spacecraft have explored is our own home in the universe. Spacecraft observations combined with atmospheric, ground-based and oceanic measurements have enabled a systematic study of Earth processes, leading to important scientific advances and tangible benefits to the American public. NASA's vision of "improving life here" starts with the Earth Science Enterprise's study of planet Earth from space. The Enterprise seeks to understand and protect our home planet by advancing Earth system science and applying the results to improve prediction of climate, weather, and natural hazards. The proposed FY 2004 budget for Earth Science is $1,552 million. The two theme areas for Earth Science are:

Earth System Science

Within this theme, NASA is deploying and operating the first comprehensive constellation of Earth-observing research satellites designed to reveal interactions among Earth's continents, atmosphere, oceans, ice, and life. These interactions produce the conditions that sustain life on Earth. Data and information from NASA satellites enable researchers to understand the causes and consequences of global change and inform the decisions made by governments, businesses, and citizens to improve our quality of life.

The $1.477 million FY 2004 budget request for Earth System Science will support the launches in 2004 of three complementary formation-flying polar orbiting satellites, which in effect will become a super-satellite. They are: AURA, which will study Earth's ozone, air quality and climate; Cloudsat, which will measure the structure of clouds to better quantify their key role in the Earth's water cycle and climate system; and CALIPSO, the NASA-French project to determine how the climate, aerosols and clouds interact. Calipso, coupled with Aura and an advanced polarimeter slated for launch in 2007 under an initiative to accelerate evaluation of non-carbon dioxide (CO_2) impacts on climate change as part of the Administration's Global Climate Change Research Initiative, will help determine the role of aerosols in climate, reducing one of the largest uncertainties in climate models.

Significantly, the Earth System Science budget will also provide $524 million, in conjunction with the administration's Global Climate Change Research Initiative, for research and modeling that will help answer critical scientific questions on climate change to aid policy and economic decision-makers.

Other major Earth Science work in 2004 that the budget will support include: Using satellite observations to provide daily and seasonal global atmospheric water vapor, rainfall, snowfall, sea-ice and ice-sheet maps to improve the scientific understanding and modeling of water cycles throughout the Earth system; Improving the predictive capabilities of regional weather models through satellite-derived localized temperature and moisture profiles; and assimilating satellite and in situ observations into a variety of ocean, atmospheric, and ice models for the purpose of estimating the state of Earth's seasonal and decadal climate.

The budget will also support the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project under development in partnership with the National Oceanic and Atmospheric Administration and the Department of Defense. This project, slated for launch in 2006, will maintain the continuity of certain environmental data sets that were initiated with NASA's Terra and Aqua satellites, prior to the launch of the operational NPOESS system in 2009. Also supported with be the Landsat data continuity mission, an innovative program to seek partnerships with industry that use critical land remote sensing data.

Earth Science Applications

NASA recognizes that by working in partnership with other federal agencies, we can leverage our research results and Earth observation information products to provide significant benefits to the American public. Within our Earth Science Applications theme we have identified applications where we can improve decision support systems, such as weather prediction models and near-airport terrain databases operated by our partner agencies. For each application, joint research and demonstration projects are under way or being developed. We are also developing cross-

cutting solutions that advance the use of NASA information and technology across a range of potential new applications.

The $75 million FY 2004 budget request for Earth Science Applications will support a focus on 12 specific applications of national priority where other agencies' decision support systems can be markedly improved based on NASA provided data and information. In 2004, NASA intends to benchmark improvements to air quality and agricultural productivity and competitively select projects for the Research, Education, Applications Solutions Network (REASON) program to serve national priorities.

Biological and Physical Research Enterprise

On their 16-day mission of exploration and discovery the seven *Columbia* astronauts conducted medical investigations related to cancer, osteoporosis and kidney stones, all with the goal of advancing our understanding of nature and the world we live in. The research operations were smooth and productive, with new phenomena being observed in combustion science and in cell science. As Commander Rick Husband said, "I think one of the legacies of NASA is that you always push forward. And STS–107 is doing that on the science side—pushing human science knowledge forward."

Our Biological and Physical Research Enterprise exists to push the frontiers of science forward. The Enterprise uses the rich opportunities provided by space flight to pursue answers to a broad set of scientific questions, including those about the human health risks of space flight. The space environment offers a laboratory, unique in the history of science, that allows the study of biological and physical processes. Experiments that take advantage of this environment extend from basic biology to quantum mechanics and from fundamental research to research with near-term applications in medicine and industry.

The proposed FY 2004 budget for Biological and Physical Research is $973 million. The three theme areas in Biological and Physical Research are:

Biological Sciences Research

Within this theme, NASA determines ways to support a safe human presence in space. We are conducting research to define and control the physiological and psychological risks posed to human health by exposure in space to radiation, reduced gravity, and isolation. This theme also conducts research and development to improve the performance of life support systems. It includes a basic biology research component that seeks both to pursue fundamental biological research questions from cell to tissues to whole organisms which produce results that can support advanced methods for enabling the continued human exploration of space.

The proposed $359 million FY 2004 budget for Biological Sciences Research will fund expanded ground research into how humans can adapt to the hazards of space flight for unprecedented periods of time under a new Human Research Initiative. A flight program in high priority areas of advanced human support technology to reduce mass to orbit and beyond for life support equipment by a factor of three is also funded by this Initiative.

Physical Sciences Research

This theme supports research that takes advantage of the unique environment of Space to expand our understanding of the fundamental laws of nature. We also support applied physical science research to improve safety and performance for human exploration and research that has applications for American industry.

Activities in this theme are structured to respond to the Research Maximization and Prioritization Task Force process, undertaken last year to prioritize BPR research activities. The budget request of $353 million will support major space flight hardware development for physical sciences research on the International Space Station, while reducing finding for lower priority areas such as biomolecular technology, and structural biology future facility class space flight hardware, and level II program management support. The budget will increase finding for research of strategic importance to NASA's long range-goals, including radiation protection and basic research enabling knowledge for power and propulsion technologies. The budget also contains funding for our new Human Research Initiative, with fiends targeted for spacecraft system innovations such as less massive fluid and thermal control methods and fire safety improvements.

In 2004, the budget supports the preparation of the first major Physical Sciences Research facility rack to the International Space Station, and the beginning of prime research facility operations on the Space Station.

Research Partnerships and Flight Support

The Research Partnership element of this theme establishes policies and allocates space resources to encourage and develop research partnerships in the pursuit of NASA missions and Enterprise scientific objectives. This research supports product development on Earth and leverages industry resources to accelerate progress in our strategic research areas. Ultimately, Research Partnerships may support development of an infrastructure that can be applied to human exploration.

A majority of the proposed $261 million budget in FY 2004 for Research Partnerships and Flight Support will apply to the Flight Support element of this theme. The Flight Support element will be augmented by two activities: (1) the transfer of the Alpha Magnetic spectrometer program management and budget from Physical Sciences Research; and, (2) the consolidation of the Enterprise Support program content and budget, previously diffused across various programmatic components. The Flight Support activity includes multi-user hardware development, payload integration and training, and payload operations support.

The budget also provides for the restructuring of NASA's Space Product Development program by aligning industrial partnerships with NASA mission needs and Enterprise scientific objectives. We intend to review our existing Research Partnership Centers to determine which of these will be retained.

Aerospace Technology Enterprise

The Aerospace Technology Enterprise contributes to the NASA Vision by pioneering and developing advanced technologies. These technologies, in turn, improve the air transportation system, access to space, and science missions. This Enterprise also develops technology partnerships with industry and academia outside traditional aerospace fields. The Aerospace Technology Enterprise is comprised of four themes:

Aeronautics Technology

NASA's Aeronautics Program develops technologies that can help create a safer, more secure, environmentally friendly and efficient air transportation system, increase performance of military aircraft, and develop new uses for science or commercial missions. This theme also enhances the Nation's security through its partnerships with the Department of Defense (DOD) and Federal Aviation Administration (FAA) and the Department of Homeland Security. Research areas include advanced propulsion technologies, lightweight high-strength adaptable structures, adaptive controls, advanced vehicle designed, and new collaborative design and development tools. In collaboration with the FAA, research is conducted in air traffic management technologies for new automation tools and concepts of operations. Major funding allocation includes three technology initiatives in aviation security, airspace systems, and quiet aircraft.

The FY 2004 budget request for Aeronautics is $959 million. It includes $169 million for Aviation Safety and Security projects, $217 million for Airspace Systems, and $574 for Vehicle Systems. The budget request includes funding for three new initiatives:

- Aviation Security—the budget includes $21 million for this new initiative ($225 million over five years); it will develop technology for commercial aircraft and airspace protection, including development of damage-tolerant structures and autonomous and reconfigurable flight controls technology to prevent aircraft from being used as weapons and to protect against catastrophic loss of the aircraft in the event of damage from sabotage or explosives.
- National Airspace System Transition—the budget includes $27 million for this new initiative ($100 million over five years); it will enable technology, in cooperation with the FAA, to transition to a next-generation National Airspace System that would increase the capacity, efficiency, and security of the system to meet the mobility and economic-growth needs of the Nation, reducing delays and increasing air transportation efficiency.
- Quiet Aircraft Technology—the budget includes $15 million for this new initiative ($100 million over five years); it will accelerate development and transfer of technologies that will reduce perceived noise in half by 2007 compared to the 1997 state-of-the-art.

Space Launch Initiative

The objective of the Space Launch Initiative is to ensure safe, affordable, and reliable access to space. Funding is focused on the Orbital Space Plan (OSP) program to develop a crew rescue and transfer capability, and on the Next Generation Launch Technology program for advanced kerosene engine development and

hypersonic propulsion research and testing. The FY 2004 budget request is fully consistent with the FY 2003 Budget Amendment submitted to Congress in November 2002.

The FY 2004 budget request includes $1.065 billion for SLI, including $550 million for the OSP to develop a crew return capability from Space Station by 2010 and crew transfer capability atop an expendable launch vehicle by 2012. Funding will support technology demonstrators such as X–37 and advanced design studies. The budget request also includes $515 million for the Next Generation Launch Technology Program to meet NASA's future space launch needs. Funding includes advanced kerosene engine development and hypersonic propulsion research and testing.

The budget envisions several key events in 2004:

- Test flight of DART vehicle to demonstrate autonomous rendezvous technology between a chase vehicle and an on-orbit satellite;
- Drop test of X–37 vehicle from carrier aircraft to demonstrate autonomous landing capability as a precursor to a possible orbital demonstration; and,
- Preliminary design review of OSP to support a full-scale development decision.

Mission and Scientific Measurement Technologies

This theme develops crosscutting technology for a variety of aviation and space applications. Funding is focused on communications, power and propulsion systems, micro-devices and instruments, information technology, nanotechnology, and biotechnology. These technology advances will have the potential to open a new era in aviation and allow space missions to expand our knowledge of Earth and the universe.

The FY 2004 budget request is $438 million, which includes $233 million for Computing, Information, and Communications Technologies, $44 million for Engineering for Complex Systems, and $161 million for Enabling Concepts and Technologies.

Innovative Technology Transfer Partnerships

This theme develops partnerships with industry and academia to develop new technology that supports NASA programs and transfers NASA technology to U.S. industry. The FY 2004 budget request introduces a creative partnership program to sponsor dual use technologies, called Enterprise Engine, and is discontinuing the existing centralized commercial technology promotion efforts and, instead, recompeting and refocusing our technology transfer programs across the Enterprises to maximize benefits to NASA and the taxpayer.

The FY 2004 budget request is $169 million, which includes $5 million for the Enterprise Engine, $33 million for recompeting and refocusing technology transfer efforts to maximize benefits, and $131 million for the SBIR/STTR programs.

Education Enterprise

Education is NASA's newest Enterprise, established in 2002, to inspire more students to pursue the study of science, technology, engineering and mathematics, and ultimately to choose careers in those disciplines or other aeronautics and space-related fields. The new Enterprise will unify the educational programs in NASA's other five enterprises and at NASA's 10 field Centers under a One NASA Education vision. NASA's Education will permeate and be embedded within all the Agency's activities.

NASA's Education Program will provide unique teaching and learning experiences, as only NASA can, through the Agency's research and flight capabilities. Students and educators will be able to work with NASA and university scientists to use real data to study the Earth, explore Mars, and conduct other scientific investigations. They will work with NASA's engineers to learn what it takes to develop the new technology required to reach the farthest regions of the solar system and to live and work in space. It is important that the next generation of explorers represents the full spectrum of the U.S. population, including minority students and those from low-income families. To ensure the diversity of NASA's workforce, our educational programs pay particular attention to under-represented groups. NASA Education will support our nation's universities to educate more students in science and engineering by providing meaningful research and internship opportunities for qualified students, plus a roadmap for students to seek NASA careers.

The FY 2004 budget request of $170 million includes $78 million for education programs including the continuation of pipeline development programs for students at all educational levels with the continuation of Space Grant/EPSCOR programs and $92 million for Minority University Research and Education. It also includes $26 million for an Education Initiative that encompasses the Educator Astronaut

Program, NASA Explorer Schools Program, Scholarship for Service, and Explorer Institutes.

Space Flight Enterprise

International Space Station

This theme supports activities for continuing a permanent human presence in Earth orbit—the International Space Station. The Space Station provides a long-duration habitable laboratory for science and research activities to investigate the limits of human performance, expand human experience in living and working in space, better understand fundamental biological and physical processes using the unique environment of space, and enable private sector research in space. The Space Station allows unique, long-duration, space-based research in cell and development biology, plant biology, human physiology, fluid physics, combustion science, materials science, and fundamental physics. It also provides a unique platform for observing the Earth's surface and atmosphere, the Sun, and other astronomical objects.

The Space Station program is well on its way to completing work on the U.S. Core Complete configuration, which will enable accommodation of International Partner elements. Flight elements undergoing ground integration and test are proceeding on schedule, and the last U.S. flight element is scheduled for delivery to NASA by the spring of 2003. FY 2004 funding drops as planned, as development activities near an end, and on-orbit operations and research becomes the focus of the program. The budget maintains proposals reflected in the FY 2003 Budget Amendment, including additional funds for reserves and funding for Node 3 and the Regenerative Environmental Control and Life Support System (ECLSS). The budget continues significant progress toward resolving the Space Station management and cost control issues that confronted the program at the end of 2001. Many changes based on recommendations of the ISS Management and Cost Evaluation (IMCE) task force have increased NASA's confidence in achieving success with the U.S. Core Complete station. Management changes have been made to ensure that ISS capabilities are driven by science requirements, and to make appropriate decisions as the program moves from development into operations.

Space Shuttle

The Shuttle, first launched in 1981, provides the only capability in the United States for human access to space. In addition to transporting people, materials, and equipment, the Space Shuttle allows astronauts to service and repair satellites and build the Space Station. The Space Shuttle can be configured to carry different types of equipment, spacecraft, and scientific experiments that help scientists understand and protect our home planet, explore the universe, and inspire the imagination of the American people.

FY 2004 budget request of $3.968 billion supports the planned steady state flight rate of five launches per year beginning in FY 2006. It provides $379 million (and $1.7 billion over five years) for the Space Shuttle Service Life Extension Program, which will improve safety and infrastructure needs to allow flying of the Space Shuttle well into the next decade.

Space and Flight Support

The FY 2004 budget request of $434 million supports space communications, launch services, rocket propulsion testing, and advanced systems. Funding is provided for cleanup of the Plumbrook facility and tracking and data relay satellite follow-on studies. The overall funding level reflects the planned transfer of certain space operations responsibilities to other Enterprises.

DISCUSSION

ISS MINIMUM OPERATIONAL CREW REQUIREMENT

Chairman BOEHLERT. Thank you very much, Mr. Administrator, and thank you for not only the look ahead in terms of the budget, but in terms of the update on the Space Station and our crew—its crew, which raises some questions. So before we get into the '04 budget specifics, let me address the issue. Now, it is my understanding that Expedition 6 Crew, the three members, will be coming home in late April or early May to replace by a two-member crew, Expedition 7. Administrator Goldin, your predecessor, had pretty much led the Committee to believe that you needed a two and a half member crew just to keep the Station functioning. And why do you feel that a two member crew will be sufficient, and what additional risks and limitations are entailed in having a two member crew? And let me get to the final question that has long been on a lot of peoples' mind, under what circumstances would you temporarily abandon the Station entirely, and how long could it stay up there in orbit unmanned?

Mr. O'KEEFE. Thank you, Mr. Chairman. The approach that we have taken—and again, in consulting over the course of the last year extensively with the—Dr. Shannon Lucid who is our Chief Scientist at NASA as a former astronaut, spent a lot of time on the Space Station MIR, is a veteran of several flights, and is a scientist of quite considerable renown or known right, has really examined the issue of exactly what does it take in order to continue operations on Station, with the International Space Station Team, and has determined that we can continue science, as well as maintain the operations of Station with a two person crew. It is not optimum by any means, but it is limited to that based on our capacity on Progress vehicles and Soyuz return egress emergency capabilities in order to provide the appropriate consumables for the consumption of the crew, water, as well as spares and logistics requirements in order to maintain safe operations on the International Space Station.

To your final point—your second point, what is it that would motivate us to de-crew or abandon the Space Station? Any safety consideration would immediately motivate us to direct the crew to get into the Soyuz Vehicle and return home, and dim the lights, because we do not want to compromise the safety of those human beings one moment. And our attempt here is to assure that we can continue to support their activity to maintain some science and research objectives aboard, not nearly as optimum as we can now, but to maintain this so that we can get to the point of returning to Shuttle Flight, and maintaining—and building the Station out to the capability we think its capable of being.

UNMANNED STATION OPTION

Chairman BOEHLERT. Then how long would the Station be able to operate with the lights dimmed as you put it—unmanned?

Mr. O'KEEFE. The best estimate there—and again, this is really very difficult to determine, because there is any number—when there is no human aboard to correct or fix any unforeseen or tech-

nical problem that may emerge on Station. Assuming all that stayed exactly right and we could move the orbit of the International Space Station to avoid debris, to keep its altitude at the appropriate orbit levels, we could probably do that for six months to a year, assuming no other unforeseen circumstances, anything that would crop up that would have no individual aboard would therefore, likely mean, an inability to make any repairs on orbit on Station at the time, and that could compromise its continued operations.

Chairman BOEHLERT. So the convention of wisdom that it requires two and a half members to just have—operate the Station is passé. You are convinced that we can operate it with a two member crew without taking on—I can understand limitations of a two member crew with additional science or limited science, but without any additional risks?

Mr. O'KEEFE. Yeah, my—more importantly, my understanding is the International Space Station Program Manager, our Chief Scientist, who is a veteran astronaut and scientist herself, as well as our partners, the 16 nations engaged in this activity are of a mind that that is a sustainable crew compliment in order to keep operations on Station going so that we can look at the earliest opportunity to return to flight and continue building that laboratory condition.

COMPARING FY03 APPROPRIATIONS TO FY04 REQUEST

Chairman BOEHLERT. All right, let me go now to the '04 budget. The NASA budget is presented in the new format this year, which has some advantages, but it makes it difficult to make any useful comparisons between the budget proposal and those of previous years.

NASA did convert the President's fiscal year 2003 request into the fiscal year 2004 format. But the more relevant fiscal year 2003 numbers are the final appropriations figures as you know from the Omnibus Bill we passed just two weeks ago. Will NASA convert the fiscal year 2003 appropriations figures into the fiscal year 2004 format for the Committee, and how quickly can it get to it? I mean that is particularly important to us so we can have meaningful comparisons and know where we have been and where we are, and like terms.

Mr. O'KEEFE. No, sir, I would be happy to work with the Committee to make that conversion. The enactment having occurred just last week, we were working a way to try to establish that. We will make that conversion as rapidly as possible. I assure you that is a high priority. We will work with you on it.

Chairman BOEHLERT. Do you have any feel for the timetable on it? I mean I assume that work is going on right as we speak?

Mr. O'KEEFE. A couple of weeks, I am reassured by the chief bean counter.

Chairman BOEHLERT. You have been characterized as a bean counter in previous forum.

Mr. O'KEEFE. Indeed, bean counters are people too.

[The requested information follows:]

	FY 2003 Enacted In approx. Full Cost
TOTAL NASA FY2003 BUDGET	**15,338.9**
Science, Aeronautics & Exploration	**7,404.9**
Space Science	**3,555.1**
Solar System Exploration	1,146.2
Mars Exploration	549.5
Astronomical Search for Origins	793.7
Structure & Evolution of the Univ.	395.7
Sun-Earth Connections	669.9
Earth Science	**1,689.9**
Earth System Science	1,591.4
Earth Science Applications	98.5
Biological & Physical Research	**933.1**
Biological Sciences Research	322.8
Physical Sciences Research	351.2
Commercial Research & Support	255.7
AM + SAGE	3.4
Aeronautics	**1,008.4**
Aeronautics Technology	1,008.4
Education	**218.3**
Education	218.3
Space Flight Capabilities	**7,908.5**
Space Flight	**6,141.9**
Space Station	1,838.6
Space Shuttle	3,835.7
Space Flight Support	467.6
Crosscutting Technologies	**1,766.6**
Space Launch Initiative	1,119.3
Mission & Sci. Measurement Tech.	453.1
Innovative Tech Trans. Partnerships	194.3
Inspector General	**25.4**

Chairman BOEHLERT. Yeah, well I understand that. The Chair recognizes Mr. Hall.

Mr. HALL. Thank you, Mr. Chairman. Mr. O'Keefe, I think as we all know, the seven families have sustained their loss and you and Bob Cabana, by the way, were super at Houston, and your condolence, and your kindness to the families, both in your speeches and the reception that they received, and the aftermath of it.

Mr. O'KEEFE. Thank you.

CREW SURVIVABILITY

Mr. HALL. But now as they go home and have time as their solace, they have sustained their loss, I find that the American people are really interested in accountability for survivability for any other sons or daughters that man those birds and reach—as they say, reach for the sky. I think that is the thing that is on peoples' minds now, probably more than anything else. And we need to be focusing a lot more attention than we have on systems that could improve any space shuttle survivability for the future. I think that is keen on their minds, and on the minds of the American people. And regardless of what Admiral Gehman's Board ultimately identifies as the cause of the accident, we need to focus on how to better protect the crew, and if we should ever lose another shuttle.

I presume we are going to be flying the shuttle—you know, my opening statement—my question here have set forth some facts, and they will have some presumptions, and one of my presumptions is that we are going to be flying the shuttle for at least another decade and a half, and maybe longer than that. That—I may be wrong on that, time will tell, but I can't imagine we will want to fly the shuttle that long without making serious attempts to increase the chances for crew survival in the event of another accident.

And when I asked you about this on February the 12th at the Joint Hearing with the Chairman here and John McCain and others, you indicated that you would be willing to take another look at the problem. I am glad to hear that and I would like to get some specifics, and one of the first questions I have is, when will you start your review of potential Shuttle-crew survivability systems? That is one thing, and I will give you a chance to answer that in a minute. Second, how will you structure the review, and what options will you investigate. Next, how much do you estimate the review is going to cost, and when will the review be complete if you can estimate or guesstimate at that. Will you have it done in time to propose any needed changes to this year's budget request that you are giving us? And when can you provide the schemata with your plan for investigating potential Shuttle-crew survival systems?

Mr. O'KEEFE. Let me do my best to work through an approach that would take—and again, I appreciate very much your comments on February 12. And we immediately began to look at that point.

The approach we have taken is to look at—in the context of the Orbital Space Plane objectives we have laid out, there is no favorite configuration of what that would look at. So as a consequence, there are at least three or four different options of what could ulti-

mately be the configuration of an Orbital Space Plane that would assure crew survivability by having that complement or redundant capability to Shuttle in order to crew transfer and return to International Space Station. So there are at least three or four different dynamic designs——

Mr. HALL. Okay, we are talking about the Shuttle now.

Mr. O'KEEFE. Yes, sir, no, you just asked about crew survivability, I apologize. So what we have engaged in is ask that group or look at all those survivability options. On the Shuttle Program itself, we are looking at—and what is presented as part of the fiscal year '04 budget is a increase in the overall modernization operational life upgrade capabilities, as well as a Service Life Extension Program effort that is reflected in the budget before you that we will adjust based on those recommendations of the Gehman Board to the extent those demonstrate they are a specific safety or survivability upgrades that are more or less required based on their findings. They won't be telling us which ones those are, but that will lead us to some conclusions, so we can specifically identify what are the most appropriate upgrades to do to maintain Shuttle operations through the next decade.

Well, that is involved there. To the extent that there is a set of recommendations that would inform adjustments to this budget, positively I will pursue those within the Administration to determine what may be feasible to come back the Congress with as a change to address that.

Mr. HALL. And the estimate, if any, or guesstimate of the cost?

Mr. O'KEEFE. I could not at this juncture. There is a——

Mr. HALL. But you will be able to later?

Mr. O'KEEFE. Yes, sir, I believe we can.

Mr. HALL. Mr. Chairman, I yield back my time.

Chairman BOEHLERT. Thank you very much, and members should know we are going to try to stick to the five minute rule on questions because there is so much interest in this and we want to give all members the opportunity to participate. Mr. Smith.

Mr. SMITH. Mr. O'Keefe, thank you for your leadership. Mr. Chairman, Mr. Hall, thank you for holding this hearing, especially at this time.

You know, over the years, our country's Space Program certainly has contributed greatly to our sense of national identify. You know, from the pride and awe that I am sure I and all Americans felt when Neil Armstrong took his first steps on the moon, to our sense of relief when the Apollo 13 crew came back safely. From the excitement generated by the wealth of scientific discovery that is resulted from the space exploration, to the deep sadness that we felt back in 1967, '68, when the Apollo 1 exploded on the launch pad, certainly in '86 when the *Challenger* exploded shortly after takeoff, and certainly when the Space Shuttle *Columbia* broke up during the final stages of re-entry.

BALANCING MANNED & UNMANNED SCIENCE PRIORITIES

You know, unfortunately, it is taken a tragedy it seems to me to focus on the needed scrutiny that we need to evaluate our Space Program. Americans want to know how the *Columbia* accident happened, but they also demand to know the cost/benefit of manned

space flight. As we consider funding levels for NASA Programs, it is important that this committee closely examine the policies most likely to benefit NASA in the future. I hope this committee is not going to shy away from that responsibility.

Mr. O'Keefe, as Chairman of the Subcommittee on Research, I have questioned witnesses on the justification for manned space flight in regard to scientific experiments because I am concerned that the cost are high and the benefits too few compared to unmanned flight or ground simulation. With limited dollars for the research and tight budgetary times, it is imperative that Congress directs its funding toward investment that give us the greatest scientific return for the tax-payers' dollar.

The *Washington Post* recently estimated the cost overrun on the Space platform was 17 billion dollars. One of the questions I have is, you have argued that NASA's investment must be driven by science, and in recent years we have seen some spectacular scientific benefits from NASA's unmanned missions. And in your budget, there is 40 percent spent for human space flight, and I guess my question is, how do you strike the right balance between the scientific efforts for manned and unmanned flight?

Mr. O'KEEFE. Indeed. Thank you, Congressman, for your very thoughtful question on that point. And on your first observation, I couldn't agree more. In the history of NASA, the highs have been very, very high, and the lows have been very, very low. And we are in the low. There is no doubt about that. And the tragedy of February 1 is certainly a reminder of the frailty of our abilities to support human space flight, as well as every other mission we are engaged in. But also, I think it speaks to the professionalism and accountability.

The balance I think is exactly as you elude. It is not an either or proposition, it is how you most appropriately develop and use technology and the capacity for robotic capabilities, et cetera, and then utilize human intervention when necessary in order to achieve the greatest returns for that technology and capacity that is there. What I use is the—or I find most instructive is the capacity of the Hubble Telescope as being the most constructive example of that.

Just last March, the *Columbia* on its last successful flight did a Hubble servicing mission in March of 2002, in which the capacity of the Hubble Telescope was upgraded by a factor of 10. A number of different servicing requirements that could only be conducted by human beings in order to do this were utilized, and as a result, the capabilities of the Hubble Telescope today are literally rewriting the science books as a consequence of the information we have gained and learned from that remarkable astronomy instrument. It couldn't have been done——

Mr. SMITH. But still, you have to compare that with Galileo, with the Pathfinder Mission, with the Keppler Space Scope. And certainly the balance seems to me is the challenge.

Mr. O'KEEFE. Very true, and indeed the astronomy community considers the Hubble to be the number one instrument that has informed their debate and understanding in a manner that could not have been accomplished were it not for human intervention.

As it turns out, the most important element of the last servicing mission, ironically, was because all of the controls are on the left-

hand side of the Hubble Service—or the Hubble modules is a left-handed astronaut by the name of John Grunfeld was able to make those adjustments because he is left-handed. And as a result, you know, that is not something we could have done remotely, and no right-handed astronaut could have done it as well. So it becomes a classic case of human intervention being an absolute necessity in order to gain the remarkable capacity we have seen that is rewriting the astronomy books. It is—and informing us of the origins of this universe.

Chairman BOEHLERT. Thank you very much. Gentleman's time has expired. That I can assure you and all Members of this committee will be the continuing focus of this committee as we go forward. Mr. Gordon.

SHUTTLE FLEET GROUNDED FOR EXTENDED PERIOD

Mr. GORDON. Thank you, Mr. Chairman. Mr. O'Keefe, last April's Subcommittee hearing on the Space Shuttle, I asked Fred Gregory how NASA would support the Space Station in the event the Shuttle Flight—the Shuttle Fleet was grounded for an extended period.

At that time he indicated that there wouldn't be a way to do that. I had assumed that a plan would have been put in place last year to support such contingency, but apparently NASA is just now putting that plan together. And as you laid out this morning, I think, that it is a responsible short-term plan to accomplish that. In that regard, you indicated in your testimony that the astronauts on the Space Station have sufficient supplies to stay up until June.

In June another Russian progress cargo spacecraft would have to be launched to the Station to support it. That is the plan.

Unfortunately, things don't always go as planned. For whatever reason, a launch vehicle failure, or an inability to dock with the Space Station or whatever, the Progress does not re-supply the Space Station in June. What is your plan? And more generally, what is your plan for supporting a Space Station in case the Shuttle is grounded for a comparable 32 months, as in the situation with the *Challenger* accident? And if there isn't a plan now, when can we expect that?

Mr. O'KEEFE. Yes, sir, well if there is no Progress vehicle that is launched in June of this year, indeed I think the most likely option that we will pursue is to ask the two astronauts aboard Expedition 7 to board the Soyuz Vehicle, dim the lights, and come home because we will not expose any member of the crew to a condition where we cannot sustain their activities for an extended period of time.

So, yes, there is a very thin margin of activity here, but there is a very important option, which is to remove the crew as quickly as possible, and there is the capacity to do that.

As it pertains to the longer-term objectives again, we believe—the basis upon which we have laid out the plan now and agreed to yesterday is through the next 18 months if need be, and laid out the flights necessary, which accelerates the two Progress vehicles, maintains the Soyuz transfer schedule that had been agreed to even prior to February 1, but is now using as a crew return capacity. And we will continue in that approach, and look, as we discussed the other day, of what would happen beyond 18 months.

So we are beginning that analysis now to see how much further beyond we can sustain that activity. And we are underway with that effort as, you know, as a consequence of our discussion the other day.

Mr. GORDON. And when would you expect that we could see a 32-month plan?

Mr. O'KEEFE. Certainly within the next couple of months I think we can analyze that.

Mr. GORDON. Thank you.

Chairman BOEHLERT. Let me poll the witness first of all. There is a great deal of interest in continuing this, and there is also, as is so often the case, this time particularly, a competing interest, and that is Governor Ridge going to be giving a briefing on Homeland Security. And the Chair, I have been appointed by the Speaker to be Senior Member of that Committee too, so more than my share of responsibilities. Would it be all right with you if we continue because there is a great deal of interest on the part of members to continue rather than to recess as originally projected? And I think we are going to have to depend on me and others who may wish to go over there to be able to brief everybody here when I come back.

In the interim we will have—is that all right with you, Mr. O'Keefe?

Mr. O'KEEFE. At your pleasure, Mr. Chairman, of course.

Chairman BOEHLERT. I am glad to turn over the Chair now for the distinguished Chair of the Subcommittee, Mr. Rohrabacher of California. And with that, I will recognize him for his questioning.

Mr. HALL. Mr. Chairman?

Chairman BOEHLERT. Yes, sir?

Mr. HALL. You know I would have been willing to take the Chair, don't you?

Chairman BOEHLERT. I sense a willingness—an eagerness if you will, but I want to keep you close to me, to the right of the Chair.

Mr. ROHRABACHER [presiding]. Well, actually some of us would have liked Ralph to come over to the Republican side and he might have been able to be Chair, so.

FLIGHT READINESS REVIEWS

A couple of thoughts, but Mr. O'Keefe, it is my understanding that NASA has a rigorous flight readiness review prior to each and every Shuttle flight, and given the risks, which now we are all too sadly aware of, of human space flight, this review would seem to be a critical moment in Shuttle launches and Shuttle safety, and as an Administrator, first and foremost, are you personally satisfied that this process is working effectively and just your thoughts on that?

Mr. O'KEEFE. Yes, sir, and thank you, Mr. Chairman.

Mr. ROHRABACHER. After all, we just did have a Shuttle disaster and this is one of the pivotal moments.

Mr. O'KEEFE. Thank you, Mr. Chairman. Indeed there is a very rigorous flight readiness review that is the culmination of lots of work that goes on for weeks and months leading up to each and every launch to sort out, and analyze, examine, and to pray over every single anomaly that could possibly have been noticed or dealt

with as the orbiter comes out of the orbiter processing facility and is ready to stack to be brought out to launch pad.

The flight readiness review is, again, kind of a culmination that usually occurs two weeks prior to the launch, in which any major anomaly or any minor anomaly for that matter is examined at great length. It usually takes at least a day or day and a half and is attended by everybody and anybody that is associated with the Program. It is held in a very large room, much like this, in which everyone is invited to and expected to speak if there is any anomaly. And each of those anomalies are worked through, and if it is not to the satisfaction of each of the participants, then the flight does not take place.

And as the voting members of that group—it is Chaired by the Associate Administrator for Space Flight, Bill Reedy, who is a former astronaut, as well as attended by the Flight or the Center Directors who are engaged in all the activities leading up to the flight itself, and it is also attended by the Associate Administrator for Safety and Mission Assurance, Brian O'Connor, who is also a former astronaut. And they must all concur before that flight is authorized to proceed.

So that process is pretty rigorous. If it is adequate or not is something I will be guided by the Gehman Board to determine whether systemically that is adequate to assure safety of flight. But it certainly is a rigorous process. If it is adequate to assure safety, that is a decision or a finding that I look forward to seeing as to whether the Gehman Board concurs or not.

Mr. ROHRABACHER. Are you personally involved in this process?

Mr. O'KEEFE. I have attended a few of the flight readiness reviews, and have had an opportunity to kind of witness this opportunity or review of each issue.

As a matter of fact, I made it a point to attend the flight readiness review of—in advance of the STS–112 Flight, which as an examination of the fuel line crack issue that you may recall——

Mr. ROHRABACHER. I see, all right.

Mr. O'KEEFE. That delayed and deferred flights from June to October until we satisfied ourselves that there was no way that——

Mr. ROHRABACHER. Okay, so you have personally—you have personally gone there to make sure that this flight readiness review is—meets the right kind of standards and——

Mr. O'KEEFE. Or at least to witness the procedure they go through and see how it operates, and I am sure was pretty rigorous to me.

ORBITAL SPACE PLANE PROGRAM

Mr. ROHRABACHER. All right, what are we doing right now in terms of weaning ourselves—this idea about being dependent on another Shuttle for another decade and a half is frightening to me, what are we doing to wean ourselves away from the Shuttle, and does that mean we are going to have to have an accelerated Space maneuvering vehicle—Orbital Space Plane Program?

Mr. O'KEEFE. Yes, sir. Well, it is two things we are doing. I think the first thing is to assure that we have a redundant or complimentary system for safe crew transfer and return to International Space Station. We have proposed as part of the President's Amend-

ment in November of 2002, the Orbital Space Plane. Now exactly what design and configuration that will be, we will know within the next 18 months or before that.

Mr. ROHRABACHER. Well, let me know, you proposed this prior to the *Columbia* tragedy?

Mr. O'KEEFE. Yes, sir.

Mr. ROHRABACHER. But don't you think that considering what we have just gone through here with the loss of the *Columbia* that this program needs to be dramatically accelerated and where does that show in your budget?

Mr. O'KEEFE. Is there—we certainly are examining as part of the earlier inquiry. The opportunities for what is the soonest we could see achievement of the selection of a design, a competitive solution, which orbiter or Orbital Space Plane alternative would be best, and move on with production as quickly as we can. That is currently being examined by the Orbital Space Plane office at Marshall Space Flight Center now.

Mr. ROHRABACHER. Well, this is something we need to look at because it doesn't seem—when you look at the long-term budget figures and you look at what we are investing in and what our needs are going to be a few years out, it doesn't all come together right now. And I——

Mr. O'KEEFE. Well, the second factor too, if I could, Mr. Chairman, I am sorry; is really, I am not all together convinced that the Shuttle is not going to be capable of operating for an extended period. Again, we will be guided by the Gehman——

Mr. ROHRABACHER. Well, we have got three. We have got the—we will be guided by the Gehman Commission, but we have got three Shuttles left, and it is a marvelous heavy lift capacity and it is a marvelous way of eating up tax dollars is what the bottom line is. It is an engineering marvel, but it is one of the most expensive systems, which in and of itself, if we rely on it too long, we eat up the seed corn we need for investing in a new system. And I won't—I know my time is up and I will move on. Mr. Lampson?

Mr. LAMPSON. Thank you, Mr. Chairman. And as for Administrator O'Keefe, I also would add my thanks to the work that you and your team are doing, particularly in light of this tragedy of *Columbia.*

The Space Shuttle is currently the only vehicle in the world that can carry the remaining components of the International Space Station that are needed to complete construction. It follows that NASA will not be able to continue construction of the Space Station until the Shuttle Fleet is back in the air.

The Space Shuttle is also the way that the United States carries crew and cargo to and from the Space Station. It is certainly conceivable that the Shuttle Fleet could be grounded for some time. We have heard several times this morning after the *Challenger* accident in 1986, the Space Shuttle Fleet was grounded for 32 months.

While the *Columbia* Investigation is moving forward, there is always the possibility that the root cause of the accident may never be determined with absolute certainty. In the aftermath of the *Columbia* accident, it may be impossible to maintain the Space Shuttles viability without help from the Russians.

IRAN NON-PROLIFERATION ACT OF 2000

Payments by Russia to cover the cost of purchasing additional Soyuz's and Progress vehicles appear to be prohibited under the terms of the Iran Non-Proliferation Act of 2000. And I know that the Iran Non-Proliferation Act provides a narrow exception allowing the President to request a waiver from Congress, only to "prevent the eminent loss of life or greaves injury to individuals aboard International Space Station". Mr. O'Keefe, have you ever asked President Bush to seek a waiver from the Iran Non-Proliferation Act, either before or after the *Columbia* Tragedy to purchase additional Soyuz or Progress vehicles?

Mr. O'KEEFE. No, sir, I have not.

Mr. LAMPSON. I believe we need to ensure that the Space Station remains operational while the Shuttle Fleet is grounded. And I also believe the Administration needs more flexibility under the Iran Non-Proliferation Act of 2000 to cover the cost of additional Soyuz and Progress vehicles at this time. Therefore, I plan to introduce Legislation today that amends the Iran Non-Proliferation Act of 2000 to allow NASA to purchase additional Soyuz and Progress vehicles, if the President notifies Congress that they are needed to ensure the safety of the crew aboard the International Space Station, and to maintain its operational viability while the Space Shuttle Fleet is grounded. To try to respond not to the crisis, but to be able to use the flexibility to plan the potential of whatever that need may be.

Obviously, the safety of our astronauts should be paramount, and NASA should not be permitted from doing whatever is necessary to ensure that that safety is maintained.

ORBITAL SPACE PLANE AND ISS CREW RETURN

And let me switch to another question. We have talked a little bit about the Orbital Space Plane, and it is my impression that NASA's schedule calls for a decision sometime by the end of 2004 as to whether or not we are even going to go forward with that project.

If NASA decides at the end of Fiscal '04 that it is not appropriate to proceed with full-scale development of an Orbital Space Plane, how do you intend to provide a crew—rescue vehicle for the International Space Station, considering that last year we canceled the crew return vehicle project in favor of the Orbital Space Plane? And the second question, the Space Station operating costs estimates developed by NASA assumed that crews and cargo would be taken to the Space Station by the Space Shuttle. If NASA also intends to fly the Orbital Space Plane to the Space Station, how much will that increase Space Station annual operating costs?

Mr. O'KEEFE. Okay, well to your first question, sir. The crew return vehicle requirements again, as I think you are aware, are contained as part of the requirements list that is summarized on one page for the Orbital Space Plane, which includes specific attribution of crew return vehicle, crew rescue capacity. And that is an accommodation as a result of the versatility as well as flexibility of that asset, which we envision to be accomplished by several different design alternatives. So I am anticipating success of picking

a successful design within the next 18 months so that we can get about the business of assuring a crew transfer capability that is maneuverable, that provides flexibility, and does accomplish the transfer objectives. And therefore, using shuttle more for its heavy lift cargo capacity as it was originally designed to do so in the first place. So there is a great complement that comes from both of these assets.

Mr. LAMPSON. Is that in 2010?

Mr. O'KEEFE. Shooting that as the current projection at present, that is what we have asked Industry to comment on, to look at the viability of that. And again, in pursuit of Mr. Rohrabacher's question earlier, that is what we are looking to seek alternatives of how that may be accelerated or adjusted based on whatever the findings may be.

Mr. LAMPSON. What will we be doing until that time?

Mr. O'KEEFE. Well, until that time—and that is the second part of your question is what do we do in order to ensure emergency egress capability for International Space Station. There is the Soyuz Module that is aboard right now. And it will be again in April and again in October. And each six months we rotate that capacity to ensure its survivability to withdraw the crew.

There are additional docking ports that could be considered, to look at additional Soyuz vehicles in the future if need be. There is a design alternative as part of the Orbital Space Plane effort to look at a capsule. It may be utilized for that purpose.

And again, the Orbital Space Plane itself, which is a crew transfer vehicle. It has flexibility, maneuverability, that we are sure, close to on-demand requirements as we can get to provide the crew transfer capabilities.

Mr. LAMPSON. Would you have been able to get access or would you be able to get access to those under the present Iran Non-Proliferation Act, or would we need to have some type of legislation like what I have spoken of?

Mr. O'KEEFE. Well, again, I would not presume what the outcome of the Congress working its way on the issues of Public Policy may yield. And so as a consequence of that, the approach we have taken with our partners is we are all acting like partners in this approach. And so the issue with exactly how the Russians would finance—the issues pertaining to the Soyuz changeup, both——

Mr. LAMPSON. We buy them directly from them. Are you saying that they might be willing to give them——

Mr. O'KEEFE. We don't buy Soyuz vehicles from the Russians directly. We have——

Mr. LAMPSON. Could we do that?

Mr. O'KEEFE. Again, under the terms of the Iran Non-Proliferation Act, there is the one exception as you cited. There is currently not a need to do a direct purchase because the partners are all participating in how, not only, we accelerate this effort, but finance it. And as a result of that, the European Space Agency for example, two astronauts had planned from ESA to fly on Soyuz in April and another one in October that was to be a compensation or agreement between the European Space Agency and the Russians, which they have now continued those payments even though those seats

will not be occupied under this new agreement as of yesterday. And they will establish that as a credit for the future at sometime.

All the partners are acting like partners. Everybody is participating and there is a disjuncture. No requirement that I see to seek exceptions or any other trading that is involved. But we will keep you posted. As we move along with this, if there—this is an uncertain territory we are in for sure. But we are all acting like partners and I am mightily impressed with the capacity of the Canadians, the European Space Agency, the Russian Cosmos, our Russian friends, and the Japanese partners, all stepping up to be part of an international understanding of how we continue operations. It is impressive.

Mr. ROHRABACHER. Thank you, Mr. Lampson.

Mr. LAMPSON. Thank you very much.

Mr. ROHRABACHER. The Chair appreciates Mr. Lampson's activism on this committee and on the Subcommittee as well. Just for the information of those present and also for Mr. O'Keefe, as Chairman of the Subcommittee, I have been talking to both members of the Russian Government and members of the Executive Branch. As I mentioned to you, Mr. O'Keefe, I think a few days ago, and this is not a contradictory at all to Mr. Lampson's legislative proposal, but that the Iran Non-Proliferation Act, which I believe is important, which is something to suggest that we would like the Russians not to be building a nuclear power plant for the Iranians as long as Iran is controlled by these radical mullahs. One other way out of that, rather than just demanding that the Russians step away from a lucrative contract at a time when their own economy is in the pits, we should be giving them a financial incentive to do so. And I have suggested to the Administration that we offer the Russians international financing or loan guarantees of some kind in order to build power plants for example for India or Turkey, which are non threatening countries, which they could then not have to suffer financially from the loss of this contract, and instead of just making a demand that they walk away. And I think that is—giving them that incentive is certainly an important thing. If that does not work, Mr. Lampson's alternative is certainly something that we need to take very seriously because we are hitting right at a critical moment and a critical part of the decision-making process that will make our success possible in the future.

Mr. LAMPSON. Well, the point in this is to try to make it—give the flexibility for action——

Mr. ROHRABACHER. Right.

Mr. LAMPSON [continuing]. So that we are not having to react to a crisis.

Mr. ROHRABACHER. Right, and with that I would like to recognize Vern Ehlers who is a Chairman of our Subcommittee on Environment, Technology, and Standards, and also is one of the more educated of members of this committee I might add.

Mr. O'KEEFE. Congressman, if you would permit me to make just a brief comment to your last statement if you would, Congressman?

Mr. ROHRABACHER. Yes.

Mr. O'KEEFE. There is no question. The issues you have just summarized are precisely the kinds of foreign policy concerns that positively have bearing on the activities the we are engaged in

now. Given the nature and the intensity of the portfolio we currently have at NASA, the last thing I want to do is to presume any part of Secretary Powell's portfolio. So I will be guided by the foreign policy objectives that Secretary Powell and the State Department view are important, and we will certainly live with that.

But at present, there is no requirement whatsoever to deal with this issue by virtue of the partners all acting like partners. This has been an impressive step-up, giving the nature of the tragedy we have experienced on February 1. And I think we should all—we are seeing the results of laboring to pull together this partnership and what it can yield. It has been impressive.

Mr. ROHRABACHER. Having witnessed you in Japan mustering the support from our Space Station partners before the *Columbia* Tragedy, I can—I understand that it is a high priority in your office. Mr. Ehlers.

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

Mr. EHLERS. Thank you, Mr. Chairman, and thank you Mr. O'Keefe for being here after all that you and Mr. Reedy have been through the past few weeks; I am sure that you could use a day off instead of appearing before us for another drilling. And I want to assure you and all of the NASA family of our continuing sympathies for them, and I appreciate all your work and Mr. Reedy's in dealing with the tragedy.

Mr. O'KEEFE. Thank you, Congressman. We are doing our best; we appreciate that.

Mr. EHLERS. Well, you have done a very good job and I appreciate that. All right, several comments. First of all, I want to—in terms of the budget you have presented, I want to thank you for the increases you have put in for the scientific research effort of the Agency.

Over the past decade, the Space Station or perhaps I should say the cost overruns of the Space Station have been an albatross around the Science Program in terms of its funding. We have not done well with many of our science efforts. We have doubled NAH. We have fast to double NSF, and my goal is to do the same for DUE and for NASA, because there is a great deal of important science to do be done, and you are the Agency to do it. So I appreciate what you have done within the limits that were placed upon you.

Mr. O'KEEFE. Thank you.

Mr. EHLERS. I also appreciate you bringing order to the accounting and the budget of NASA. I assumed you would do that when you were appointed. I think that is one of the big reasons you were appointed. And that is great progress.

METRIC SYSTEM OF MEASUREMENT

I hope you will also bring sense to another area, and that is introduce the metric system to NASA. I cannot understand this—an Agency that is supposed to be science driven still not using entirely the metric system, and we have 160 million dollar loss as a result of that. I have introduced a bill to deal with that, and out of kindness to NASA, I have let it languish, but it is time to reintroduce that and pursue that. There is no reason in the world, when the rest of the world uses the metric system, that NASA should con-

tinue to use the non-metric system in part of its operations. So I hope you can bring that same sense of good accounting to that problem as well and say we got to uniform—make it uniform, it is cheaper; it will save money, and so let us do it.

Mr. O'KEEFE. I am trainable, Congressman, I will work on it.

PROJECT PROMETHEUS

Mr. EHLERS. Great, I also want you to succeed at it. On the Prometheus Project, that has been kicking around in one form or another for many, many years, what has changed that makes you and the Agency believe that this is worthwhile to pursue at this time? Have there been some breakthroughs in it or do you simply believe that the time is right to make this work?

Mr. O'KEEFE. Yes, sir. Well it is—it certainly is a known technology. There is no question, we know how to develop a harness, nuclear power for what has been the equivalent for—I think about 125 million miles that our U.S. Navy assets have utilized, which is roughly the distance between here and Mars, by the way, that they have conducted safely during the course of the better part of 35 years of their experience. And so we are seeking to work with them, given their design prowess and capacity for understanding reactors for a much smaller reactor requirement that we have than what you would ever utilize on an attack submarine or an aircraft carrier, which again proficiently developed and designed and operated safely for many, many years.

To take that same design prowess and apply it to a much smaller requirement for power generation and propulsion capability, and to get on it with, let us go ahead and let us begin developing that, which will improve speed for in space propulsion for traversing, by a factor of three, or establish a considerable on-orbit time, which we currently don't have the opportunity to do.

And to your point, I think very importantly, Congressman, of the science objectives, the thing that is most impressive I think about the capability of utilizing this propulsion and power generation capacity is that it provides a factor of 100 greater of power capacity for science and research objectives than what was currently deal with. Right now, any space probe that we send up—any space craft, be it any one of the number of capabilities we use for scientific unmanned capabilities, basically requires a power generation of roughly the equivalent of two 60-watt light bulbs.

So all the scientific and research objectives have to be built around that limitation. Now, we are looking at something that is 100 times greater than that simply because of the power source we are using. Is it the best approach, I don't know. I think there may be some future ones that are better, but it certainly is one that is mature enough, we can get on with this, and finally make a technical breakthrough that has been long overdue.

Mr. ROHRABACHER. But it is my understanding is you are going to use it for propulsion as well as operating?

Mr. O'KEEFE. As well as power generation, yes, sir.

Mr. ROHRABACHER. Both, right, and that of course—then of course your limitation is whatever material you are using. And I believe you are using xenon?

Mr. O'KEEFE. Yes, sir, but let me get you more information for the record though.

Mr. ROHRABACHER. I would appreciate that because——

Mr. O'KEEFE. Yes, sir.

Mr. ROHRABACHER [continuing]. This raises a host of other questions in my mind—technical questions, which is probably not appropriate to ask at this point. And so I would appreciate some additional information.

Mr. O'KEEFE. Yes, sir, I would be delighted to provide that.

MATERIAL REQUESTED FOR THE RECORD

Xenon is only one of the potential fuels we are currently studying. We will not know the exact fuel for a couple of years.

PLANNING FOR TWO-PERSON ISS CREW

Mr. ROHRABACHER. All right, just one last comment at the request of Chairman Boehlert who had to leave. You suggested that NASA had already studied the risks associated with a two-person station. Are you planning any new assessments of that risk at this time?

Mr. O'KEEFE. Again, I am be-guided by three very important inputs, the International Space Station Program Management, which has really worked over this question very, very hard in leading up to the options that were agreed to yesterday, from a technical standpoint, Shannon Lucid, as the Chief Scientist from her operational experience as that—as well as that of a scientist who understands exactly what the parameters of requirements are, and by our international partners, who have agreed to and have participated in this particular process to arrive at the conclusions we talked about this morning. That triangulation of I think very deep expertise at least satisfies met that the right technical folks, the right safety concerns, and the right scientific objections have been—and our partnership arrangements have been factored into this conclusion.

Mr. ROHRABACHER. So you don't plan a new assessment then?

Mr. O'KEEFE. We are going to continue to look at—this is uncharted territory we are in, so in that regard, if there is any adjustment need to be made, again, the last thing we will do is compromise the safety of the humans aboard the Station in time, and we will dim the lights and come on home if there is ever a concern that raised on that front.

PROJECT PROMETHEUS

Mr. ROHRABACHER. Thank you. And just quickly, when I asked how much xenon you had to have onboard? I was told 3,900 pounds.

Mr. O'KEEFE. Is that right?

Mr. ROHRABACHER. My question was how many kilograms was that?

Mr. O'KEEFE. I will work on a more proficient answer, sir.

Mr. ROHRABACHER. That was, boy. Vern does that to us too, I will tell you that much. We now go to Mr. Weiner, who is a—Congressman Weiner who is a very active member of this committee,

and especially has shown his interest in the past in aeronautics. And Mr. Weiner, you may proceed.

SPACE SHUTTLE ACCIDENT INVESTIGATION

Mr. WEINER. Thank you. Mr. Administrator, Mr. Chairman, this hearing not withstanding, the title of the hearing has been a surreal exercise in ignoring the elephant in the room.

Today we see on the front page of our daily papers memorandum from members of your staff of contractors, that in a hauntingly way show that there were investigations, research, theories and memos about what could have gone wrong that predicted almost to the point.

Putting to the side of whether or not you are always going to find memos, you are always going to find people saying different things; I pick up today's *USA Today* and find that not last month, not three weeks ago, but yesterday, you were interviewed by the USA Today Editorial Board. And you said in a response to a question, had there been any indication before 8:52 on the morning of February 1, we would have used every ounce of energy, capacity, and professionalism into solving the problem. That is yesterday. Internal—and when asked about e-mails that had become public, you said that they were resolved at the operational level.

But perhaps what is more stunning is you had informed the Editorial Board you hadn't even read the memos yesterday. You know, we have offered a lot of praise for you. I personally have, for trying to not repeat the errors made in the *Challenger* incident, where it was not Congress that solved the problem and got to the truth. It was not NASA. It was a whistle-blower and reporters that did it.

Now I would point out that the e-mails that were revealed yesterday were subject to Freedom of Information Act requests. I have two questions, sir. First of all, why was it that even if there is a hint of a footnote of a memo on a scrap of an envelope that was within this investigation scope that it only made its way to you yesterday at the same time it made its way to everyone else on the AP Wire? And have you fired anyone for not bringing them to your attention sooner?

Mr. O'KEEFE. The release of information, again—what we have been responding to now, our first priority each and every time is every time the *Columbia* Accident Investigation Board asks for any information we produce it immediately. And we are trying——

Mr. WEINER. May I interrupt you on that point?

Mr. O'KEEFE. Of course, by all means, sir.

Mr. WEINER. So they had it before you? When did they get the memo?

Mr. O'KEEFE. I don't know when they receive those e-mails.

Mr. WEINER. So they would have to ask, do you have any memos for Mr. Jones on February 17 that we should know about? Exactly——

Mr. O'KEEFE. No, sir.

Mr. WEINER. I mean it is just stunning to me that this is being the process that is being followed, because if you recall, sir, this is exactly what happened. We had to wait for something to bubble up to the surface, and you are the Director—and you are the Administrator.

I am just curious. Perhaps we should take a step back. You have a Space Shuttle in the sky, okay. I can't think of anything more important on your desk when a Space Shuttle is up in the sky besides—than how is it doing, okay? And I cannot imagine—I mean, is that fair to say that that is probably job one of the Administrator when the shuttle is up in the air to be keeping an eye on what is going on with it?

Mr. O'KEEFE. Yes, sir.

Mr. WEINER. Okay. So am I to believe that there is a level in the information flow below which you aren't devoting any level of analysis. There is no memo coming to you? I would be surprised if there is one person in the entire organization that raised a concern, you as the Administrator would not want to be aware of.

And this was a vigorous debate among experts going back and forth. Now admittedly, again, I am not informed enough to make a decision about whether it was right, or wrong, or anything else. God willing, we will come to that conclusion soon, but what is absolutely amazing to me is that I read the stuff before you did. I mean that is crazy. I mean don't you agree? I mean aren't you—you must have gotten these memos and hit the roof, is that a fair characterization?

Mr. O'KEEFE. Let me try to respond to your earlier questions and I will try to arrive at each of the ones you just raised. I apologize for the time.

The first one is, again, we are releasing every bit of information, not when the Accident Investigation Board asks for it. We are trying to get it out as fast as possible——

Mr. WEINER. Sir, I have eight seconds left.

Mr. O'KEEFE. Yes, sir.

Mr. WEINER. I am not really interested in when the New York Times got it. I am interested in when you, the guy we put in charge of this got it. When did you get it?

Mr. O'KEEFE. Let me try to answer each of your questions.

Mr. WEINER. No, that is the one I am most interested in, in my last eight seconds.

Mr. O'KEEFE. Well, I am sorry, sir. I thought each of your questions were equally important.

Mr. WEINER. No, no, no, I prioritize on each——

Mr. ROHRABACHER. Mr. Weiner, we will be happy to extend you another minute to make sure that the Administrator will be able to answer your questions.

Mr. WEINER. Thank you, sir. The most important thing I want to know——

Mr. O'KEEFE. Yes, sir.

Mr. WEINER [continuing]. Is when you found out about it? What you did when you found out about it? And what—I mean and just to get some reaction to the idea that you got it yesterday afternoon.

Mr. O'KEEFE. We have been collecting up all of the information here, all of the facts, all of the evidence, every piece of information involved, and upon an examination of that, releasing it without any filtering from me. Again, we are trying desperately to be sure that we put everything out on the table as we are able to collect it all; and it is an awful lot of information being done. And if you would, sir, please. There is a process that is underway, I think, to collect

all that information on every anomaly that may have been noted and discussed and debated.

One of the other ones I have looked at is the temperature and the climate control aboard——

Mr. WEINER. Standby, sir, I have to interrupt, because frankly, sir, this is a problem that I think we are having in gathering information about this. I want to hear about the other anomalies, believe me I do; we all do. I have a limited amount of time. I cannot imagine if I am running the Agency, and hopefully we are never in that unfortunate position, that if I am running the Agency, on February 1 I sent out an e-mail to every single person, send me any possible thing that you might have known to go wrong, and I would have done nothing—stayed up all day and all night as the Administrator to read it. And then the first question I would have asked is you know what, if we had this observation and this type of investigation going on, I am in my office. I am the Administrator of NASA; I have a Shuttle up in the air that has reached the point that just like in the *Challenger* accident, there were people that were saying troubling things.

That is what I am concerned about. I am not concerned about your disgorging information——

Mr. ROHRABACHER. Mr. Weiner, we could—I would be happy to give you more time to have the Administrator answer your questions——

Mr. WEINER. Sure.

Mr. ROHRABACHER [continuing]. But not for you to go on and on.

Mr. WEINER. That is certainly fair and I apologize for being a little hot under the collar. But my concern is not about all the anomalies or how it was disgorged, or how great you have been in letting people know what is going on. My concern is from your desk; how it is that your finding out things after I am. I mean this shows—seems to me to be a fundamental problem in the management of the Agency.

Mr. ROHRABACHER. Mr. Weiner, we will give the Administrator one chance to answer the question then we will move on.

Mr. O'KEEFE. I will do my best Mr. Chairman and Congressman. Again, the approach that we take on every operational activity is that we encourage, expect, demand that everybody exchange what they believe to be the solutions or difficult—we are responding to anomalies that would occur on flight. There are lots and lots of these. Again, this flight readiness review went through a full day and a half leading up to that weeks before hand. There are lots of different issues that are worked through. I certainly am not privied to every single one of those deliberations that go across an Agency of 18,000 people and another 100,000 folks who are engaged in launch operation and the continued activities of the Agency.

As we work through this, we are expecting that folks at every responsible level will work through this. And based on what I can see, the venting of all this information that occurred on orbit during the operational mission was handled by the individuals. They vented those questions, satisfied themselves that there were solutions that could be found, and determined if there was a safety of flight risk to be attended to that, and ascertain that there was not, in their judgment.

The thing I am really anxious to see, Mr. Congressman, is when the Gehman Board comes to conclusion on this. Is there a systemic or management question of where those judgments are made that needs to be altered. And that is the point I think that is central to all of your inquiries, if I could, sir. And that is the point that I think we really need to examine very, very carefully.

The proposition that every single piece of correspondence and discussion will move through a single filtering aspect means that we would have gridlock. And so in that context, there is an expectation that people will be professional, step up to those responsibilities, iterate those questions, and they do on each and every one of these flights. And that is what happened in this case, and absolutely will be guided by the judgment of the Board as to whether that was an appropriate systemic or management approach to it. But it sure looks like that dialog went on at the exact right levels for the operational considerations.

Mr. ROHRABACHER. Thank you very much, Mr. O'Keefe. And let me know, all of us on this committee are looking forward to the Gehman Commissions' Analysis of these very issues that Congressman Weiner is bringing up, and many other issues that we know that are vital to determining exactly went wrong—what went wrong, and whether or not people—which people should be held accountable if mistakes were made. And I am not an expert, Congressman Weiner is not an expert on this, but it is important for us to bring these up, and we do expect to have the answers from the experts on the Commission within a few months at least.

Mr. O'KEEFE. Yes, sir. We want to know the truth. There is no question about that at all. And we are going to find out what it is. We are going to make the corrections necessary as recommended, and we are going to figure out what it is going to take to get back to flying safely, responsibly, and accountably.

Mr. ROHRABACHER. Thank you very much. And now we have Mr. Bonner from Alabama.

Mr. BONNER. Thank you, Mr. Chairman. And Mr. O'Keefe, in light of your most recent statement that you want to get to the truth, and in light of the previous question as well, I worry about some in the media, some in Congress, and some investigators are putting too much emphasis on trying to assess blame on this tragedy. Clearly, as we pursue an investigation such as this, we have got to do everything we can to get to the bottom of what caused the tragedy and what we can learn to ensure that such a tragedy never occurs again.

In military accident investigations, the primary thrust has historically been on determining the real root cause of an accident, thereby allowing for meaningful corrective action to take place, rather than trying to affix blame.

The search for root cause is aided immeasurably by a free and open flow of information that occurs between the investigators and the hundreds of technicians and other people that take place.

I worry, and I think many in this body worry that if we try to affix blame solely, then those hundreds if not thousands of people who are concerned more about protecting their backsides than providing that information to get to the root cause and to find out what happened will in fact that process will be stymied.

So I guess my question is, are you comfortable thus far into this investigatory process that an open and free flow of information is occurring? And do you feel that we are doing enough to encourage such a free flow of information?

Mr. O'KEEFE. Yes, sir, there is no question in my mind that is what is occurring, and more importantly in my opinion or view, that is Admiral Gehman's view. And the members of his Board are absolutely of that mind. And as a consequence, there is just a tremendous amount of information that is being analyzed now, but it is all being made available. And I am stunningly impressed by the professionalism of every individual in this Agency, who is participating to make sure this is an absolutely open and above board process where every, you know, scrap of information is available for examination to determine what happened here. We don't know, and they are narrowing down, I think through a very disciplined way, on the Investigation Board exactly what the causes could be and using precisely the methodology you described, very succinctly of trying to narrow down what those theories would be, and then move ahead based on the preponderance of evidence on what they think the cause or probable cause would have been.

Mr. BONNER. Shifting gears a little bit because NASA obviously has many important issues on its plate. Many people, I think, over the years recall with fondness, sitting around our television sets and watching with anxious breath, watching the Apollo missions succeed, watching man take its first step on the moon. And over the years that have evolved, sadly it has taken *Challenger* and *Columbia,* the tragedies to make us aware of the real danger and risk associated with these missions that have occurred in the years that have occurred since that time.

SPACE EXPLORATION BENEFITS

But one of the things that I think many Americans are looking for is what is the ongoing mission, and how do these Space explorations continue to benefit those of us here on Earth at this particular time? One thing I am particularly interested in is a Member of Congress who represents the Gulf Coast and the First District of Alabama is the work that NASA is doing with regard to Red Tide. It is something that effects not only—we have lost a lot of species. It has also had a negative effect on the health of people along the Gulf Coast. I would appreciate it if you could—if NASA could get me some additional information on that type of research. And I think that is just another example of where the research that you are doing with your Agency and work with the other agencies, like NOAA, is actually going to help benefit the quality of life here on Earth. I thank you very much for your very difficult job that you are doing that I commend you on very much.

Mr. O'KEEFE. Thank you, Congressman. I appreciate that very much. I would commend to you, sir, that the strategic plan I referred to earlier, which we have labored mightily to make sure it is readable. Most strategic plans are mighty fine doorstops. This one we really worked on for many, many months to be sure that it explains as succinctly and, you know, narrowly, so it is not an intimidating size, that really lays out what the strategy is and the approach we are looking at. And in there is a specific discussion

of the kind of Earth Science programs that we are engaged in. In pursuit of the Climate Change Research Initiative the President expects that we will be supporting. And roughly half the assets that are necessary to complete that task are assets that NASA is employing for those purposes to understand and protect our home planet as the primary first mission objective that we stated incurs. But it is a comprehensive approach, and I would be delighted to make sure you have further information on that specific activity on its applications at our—at the—at your convenience, and we will produce it right away.

MATERIAL FOR THE RECORD

NASA's contributions are in two types. Several of the Earth Observing Satellites NASA has launched over the past five years are used by researchers in other government agencies and in academia to study the biology in the coastal oceans. In addition, NASA funds some peer reviewed scientific investigations in the context of its broader research strategy.

NASA's Earth Science Enterprise's (ESE) research on "Red Tides" and other forms of Harmful Algal Blooms (HAB) is coordinated through the multi-agency program ECology and Oceanography of Harmful Algal Blooms (ECOHAB). Other members of ECOHAB include the National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA), and the Office of Naval Research (ONR).

The agencies formed ECOHAB in 1997 to collaborate on the collective goals for the detection, understanding, monitoring, modeling, and management of HABs. ECOHAB sponsors an interagency solicitation of research proposals each year. Each agency has their respective research goals for participation in ECOHAB, and each funds proposal that align with their respective goals and missions.

NASA's research goals and activities in ECOHAB include: development of remote sensing techniques for detection and tracking of HABs in near-shore coastal environments, differentiation of HABs from suspended sediments and organic compounds in optical sensors, quantification of pigment concentration and understanding of optical properties associated with HABs in near-shore waters.

NOAA conducts research through ECOHAB on the relationship of HABs to the surrounding environment in order to apply effective techniques for prevention, control, and mitigation to communicate and reduce the impacts of HABs. Through ECOHAB, NASA and NOAA coordinate research on development and use of remote sensing data and techniques and characterization of HABs for detection and tracking.

NOAA and EPA are the primary Federal Government agencies funding HAB research, and these agencies have specific HAB-related programs. NASA's ESE funds HAB activities through existing Earth science programs, rather than through a separate program dedicated to HABs.

ESE funded a project entitled "Eco-physiology of sub-populations of *Alexandrium tamarense*," for $512 thousand (covering FY 1998–FY 2002), through the ECOHAB solicitation. The objective of this project was to examine the factors that cause the *Alexandrium tamarense* alga to bloom.

Prior to FY 2003, the proposals submitted to the ECOHAB solicitation that aligned with NASA's objectives were judged "low" by the ECOHAB peer review process. However, three proposals submitted to the ECOHAB FY 2003 solicitation align with NASA's objectives.

1. NASA has selected two proposals for funding: "Satellite Analysis of the Physical Forcing of Algal Blooms in the Pacific Northwest Coastal Ocean" (approximately $387 thousand over three years) by the Applied Physics Laboratory, University of Washington—seeks to integrate and analyze satellite data sets to identify and monitor physical conditions that favor HABs in Pacific Northwest coastal waters.
2. "Role of mycosporine amino acids in UV photoecology of harmful dinoflagellates" (approximately $388 thousand over three years) by Scripps Institute of Oceanography, University of California San Diego—seeks to improve early detection of harmful algal bloom formation and predict growth of species of concern.
3. In addition, NASA and ONR have selected the following three-year proposal for funding: "Optical Detection and Assessment of the Harmful Alga, *Karenia*

brevis" (approximately $595 thousand) by the University of Southern Mississippi—to refine and evaluate optical approaches to detect and monitor bloom events of the red tide alga, *Karenia brevis.*

Mr. BONNER. Thank you. Thank you, Mr. Chairman.

Mr. O'KEEFE. Thank you, Congressman.

Mr. ROHRABACHER. Congressman Wu has had to leave, and he wanted me to mention for the record that he will be submitting written questions to you about the nature of the ceramic tile and some of the problems there. And I would let everyone note that there will be written—you can present written questions to the Administrator at the end of the hearing or within the week afterwards, and we would expect them—those questions to be answered by NASA.

In the meantime, Mr. Davis from Tennessee, a—who is a freshman, I believe, and a new member of our Committee, will proceed.

Mr. DAVIS. We are supposed to turn the speaker on, I guess. And one of my first questions I would like to ask, as a member of this committee and make a comment as well.

Five hundred and some odd years ago, we started reaching out and found the 30 continents on the Earth. And I know that as we look into the future with our space program that we are looking to go to different planets and maybe even be on that—other solar systems. And I certainly applaud the vision and the courage in those who work with NASA to reach out and to search beyond where we are today, to go to the stars that some of those earlier folks looked through enhanced visions through telescope and identified some of those, and quite frankly, did quite a good job. We haven't done much of that, even in modern time. We haven't found much greater in our stars than was there—defined over the last several hundred years.

One of our better citizens, I guess, most revered citizens, Roger Crouch, an astronaut that was on a space shuttle 83 and a space shuttle 94. I know that the one 83, a lot of concern as we saw one of the fuel cells, I think, that stopped on us and we had to shorten that flight to four and a half days. And my grandson, he was six years old, was able to see number 94 go up of which Mr. Crouch was on.

I know that exploring space is something that is certainly important to all of us. As Kennedy said, the new frontier is not beyond the Mississippi River, necessarily, the new frontier for America is to walk on the moon. And in 1969, as scoutmaster, I sat with a group of young boy scouts who saw the landing on the moon and the pride that all of us in America had as we captured the first place as being in space. And I understand as we do these flights with the shuttle that we do quite a bit of research, some that perhaps might even find a cure for an illness that we have, perhaps new materials will make it more comfortable or easier to live here on Earth. And I applaud that research as well. And I hope that we don't allocate funding searching for the stars when we still have a lot of searching to do for those of us who inhabit the Earth.

CATASTROPHIC FAILURE RATE

But a question I have, and I hope that you might be able to answer this, I also watched, my wife being a teacher as the *Chal-*

lenger in 1986 that we lost, and at that time, there had been some estimates when we first started talking about space flights, the possibility of losing one flight in a thousand was something that we had to accept, that there were chances in flying into space. And when that one blew up, we decided it was one in 78, and now we have one in 57 is the record that we have for those that—for our space shuttle flights. The question I have is what accident rate is too low or too high for us? And I think that we need an honest debate on establishing some rate, an accident rate, over the next few years to be sure that those that explore the on Earth for Americans greater than we have. And I question whether or not we should continue to target dollars somewhere beyond Earth when we really ought to be putting more dollars in NASA or targeting more of those dollars for research that would improve the quality of our lives here on Earth.

Mr. O'KEEFE. Yes, sir. Now I agree. There is no question that the risks involved in this activity are not inconsequential. We have seen that traumatically displayed, and there are no more, I think, courageous people than I have met in these last four weeks than the families of those astronauts. They are absolutely stunningly inspiring people. And they have dealt with this in a way that, frankly, I just don't know if any of us would have been as strong as they have been. It is an extraordinary effort. What they also have reminded me, though, each and every time I have had a chance to talk to them, is that each time we are engaged in these activities of exploration throughout the history of humankind, there is always a risk attendant to that or else the safest way to do it is don't go at all. And it is—I think the important question you have raised and one that I find really something that requires a soul search is at what point do you say the potential cost of exploration, going there to a place that is not typically gone to or gone to at all, that at what point do you say it is not worth that potential risk? And if that were the case, I think as you started in the very beginning of your commentary, we would not have achieved what we have as human beings over the course of, you know, lots of exploration objectives. Lewis and Clark would have quit in the first few days. Magellan would never have taken the trip instead of coming back with only three of the original crew members he began with.

I mean, there are just a number of different events in human history that if you look to, it really has to be worth that price. And that is the more important point that I think you have identified that is really occupying my thought on this question of it. What stage is the yield of what it is we think we can gain by the continued exploration relative to what that risk is once we manage that to the lowest level we can within the limits of human frailty?

Mr. ROHRABACHER. Thank you very much, Mr. Administrator. And one wonders what type of investment and the ice moon of Jupiter is going to return to us and what the total expense is going to be over the whole trip, which we haven't gotten into yet, but maybe we will——

Mr. O'KEEFE. Yes, sir.

Mr. ROHRABACHER [continuing]. Later on. We now have Mr. Feeney from Florida, another freshman that has been very active

in his own state government, now he has come to show his talents nationally.

SHUTTLE WORKFORCE

Mr. FEENEY. Thank you very much, Mr. Chairman, and thank you, Mr. O'Keefe, for again appearing before us. And I understand that the overwhelming issue that all of us are interested in is the investigation and hopefully the cause of the tragedy, which we can remedy.

But we still have to do a budget, and this is a budget hearing. And so as opposed to trying to force this watched pot to boil quicker as we try to get to the bottom of the investigation, I would like to focus my questions on budget-related matters. How and what do you anticipate, and I understand that there are a lot of things that are still up in the air related to short and long-term planning as a consequence of the disaster, but how do you plan to utilize the shuttle and the International Space Station work force at the Kennedy Space Center in particular but elsewhere as well during the stand down period for the shuttle fleet? Do you see any immediate reductions in these work forces because of the stand down? If so, when do you anticipate those decisions would be made and what can we do for the employees that may be effected?

Mr. O'KEEFE. Well, as our experience, again, has been that each time there is any anomaly that we see that would compromise safety of flight, we have done the stand down. As recently as June to October of last year was an extended stand down as we worked through the fuel line crack issues that we had detected on one orbiter to make sure they weren't on others. And during the course of that time, that required, I think, a continued activity on the part of all of the folks in the work force both at NASA as well as contract community that support the launch activities that is a lot of busy—a lot of work still continuing to go on. And we are anticipating, as soon as possible, returning to safe flight as the recommendations of the Board are released. To the extent that that permits us to do so, we shouldn't see any diminution of that. Right now, the next orbiter that was to have launched in March is Atlantis. It was stacked and ready to roll out to the launch pad. We are now destacking the orbiter to assure that everything and anything that needs to be examined here in the course of our investigation and of the—and the Gehman Board's review of said investigation is examined to assure safe flight.

So there are plenty of things to keep lots of folks busy. And they are very, very diligently working all of that as well as continuing to receive the International Space Station components that are coming and delivering to Kennedy. I think at the end of next month, the Node II, which is the primary configuration component that permits the attachment of all of the international partner modules in the future is due to arrive at Kennedy. And that will take a—the better part of a year of testing and check out and assuring that all of those parts are compatible with all of other components that are involved there. So there is a lot to do, and there is an incredible attention to detail that is going on at each of the centers, particularly Kennedy as well, in doing this, as well as the reception of all of the debris that has been trucked to Kennedy to

lay out to give us a better understanding of what could possibly have happened on this flight. So a lot of busy activity going on and a lot of folks really attended to it and spending an awful lot of time above and beyond any normal workday. They are really dedicating themselves to it everyday, and we are very proud of them.

Mr. FEENEY. But no immediate intended——

Mr. O'KEEFE. I can't—I don't know what we could do without them.

ORBITAL SPACE PLANE

Mr. FEENEY. Wonderful. Mr. O'Keefe, while we wait for a fix to the shuttle problem, should Congress decide to appropriate additional resources for an expedited development of the Orbital Space Plane, could we shorten the time frame and get into action before 2010 in a meaningful way, in your opinion? And what would it take in terms of resources to do that?

Mr. O'KEEFE. Might be able to, and that is exactly what we are looking at now. We are trying to—you know, the Orbital Space Plane Program Office and our Aeronautics Technology Enterprise folks are looking at that very, very carefully right now to try to see what permutations of the schedule we could look to to accelerate that activity. So we should have some answers to that in a relatively short order.

DEPARTMENT OF DEFENSE COLLABORATION

Mr. FEENEY. And finally, can you describe the collaborative efforts between Department of Defense and NASA with respect to the next generation launch vehicles? Are we working well together? Are there additional things that we need to give you in terms of tools and resources to work with DOT in that regard?

Mr. O'KEEFE. I think it is doing exceptionally well. We have a standing partnership arrangement that we work with all of the elements of the Defense Department, particularly the Air Force and the Strategic Command, the Defense Research and Engineering activities in order to really contribute heavily to the activities of the next generation launch technologies. Dr. Ron Sega, who is a former astronaut, as a matter of fact, is the director of Defense Research and Engineering. We have worked very, very closely and very collaboratively on hypersonics capabilities, a range of different programs that they see applications for that we also will view for the future. And we are looking to accelerate that. It is a very close, extremely professional, and personally rewarding arrangement and relationship that we have that I think is doing nothing but yielding great dividends. So we are going to continue on that effort as well.

Mr. ROHRABACHER. Thank you very much, Mr. Administrator.

Mr. O'KEEFE. Thank you, Congressman.

Mr. ROHRABACHER. And we have Mr. Bell from Texas, the 25th Congressional District.

Mr. BELL. Thank you, Mr. Chair. And I am actually from Houston, Texas, and so the impact of the space shuttle tragedy has been fully felt in my district. And I very much admire the way that the Agency has conducted itself and the way you have handled the situation personally. And I want to say that. And obviously, it is ex-

tremely important to people in my district to see the space program move forward.

DE-CREW ISS

I wanted to try to achieve some clarity on something that you said early on in your testimony here today in response to a question from the Chair. And I think I understand what I mean, but I think it is awfully important as we move forward and as this discussion continues about where the space program is going. And you were talking about the space station and what would drive the decision to "dim the lights," I think was your expression and talked about any safety consideration would lead—could lead to the dimming of the lights.

And what I think is very important as this debate moves forward is that people not forget that there are huge inherent risks involved with man space flight and that astronauts willingly accept those risks when they decide to take part in the program. And so what I would like for you to perhaps touch on is when you talk about safety considerations, and I think everybody realizes that every effort is made to make every mission as safe as possible. But what kind of safety considerations are we talking about that could lead to a dimming of the lights?

Mr. O'KEEFE. Well, again, I agree with you entirely that ethos of the astronaut corps and the cosmonaut corps is that you take every single alternative before you ever abandon anything. There is no doubt about it. There is a very committed, extremely professional, well-trained, and extraordinarily impressive group of people who are committed to that set of objectives. There is no doubt about it.

The kinds of things that I think would compromise safety in these cases, and we have got multiple scenarios we have worked through and simulations of what could happen and work on International Space Station to look at each of the potential permutations of what could occur that would necessitate abandonment. And it is a very low number of circumstances. There is no doubt about it. A fire aboard the International Space Station in and of itself may not, necessarily, necessitate abandonment. If it can be contained, worked, and they have all been trained to deal with those kinds of questions then they do just that. And it is the last possible alternative they consider is to leave.

The point that I think the Chairman raised that I think is particularly relevant in this case is that our margin that is necessary to support, sustain permanent presence aboard International Space Station until we return to a shuttle flight is dependent upon not only the capsule always being attached so that they have an emergency egress capacity, but also the continued Progress flights, the re-supply flights, the autonomous, unmanned vehicles that bring aboard water, consumables, spares, logistics capabilities. If for whatever reason, and I think this is an important point that Congressman Gordon raised, that that succession of flights is not achievable, then the idea of leaving them there for a sustained period of time without the capacity to support them is something we would have to consider seriously as a basis upon saying, "Time to dim the lights and come on back." And again, that is a decision we

would make as a partnership among the 16 nations involved. And there is a reticence, deep reticence to want to leave that unmanned for any period of time because of the uncertainties of what could occur when there is no individual aboard. But it, nonetheless, is something, I think, we have to look at as an act of consideration to recognize what the challenge and risk is of continuing this activity. I think you hit the nail right on the head.

Mr. BELL. You also talked about taking a stepping stone approach in this budget. And the Orbital Space Plane is talked about or addressed in the budget and the space station is addressed. I assume those are some of the stepping stones that—to which you refer, and I am curious as to how the shuttle investigation may impact those stepping-stones. What effect could that investigation have on any of the overall plan or budget?

SHUTTLE SERVICE LIFE EXTENSION PROGRAM

Mr. O'KEEFE. It is pure speculation on my part to determine what it is Admiral Gehman and his Board may or may not come up with. I just—it would be a wild guess, and I have no idea exactly what the contents of that potential set of recommendations could be. Nonetheless, I think it is important that we position ourselves to look at what shuttle modernization, maintenance, upgrade, and continued operations requirements we would have. We are going to convene in March, as a matter of fact, with a group of folks that all look at every possible upgrade approach that would—and we had planned this prior to February 1 to get together to think about what it is going to take to extend the service life or maintain the service life of this asset through the next decade potentially.

On the Orbital Space Plane, again, there is a set of options we are looking at and have to examine in terms of what adjustments to the schedule might be possible as we work through this. Continuing discussions with our partners in terms of what it would take to continue or accelerate the number of Progress flights, the number of Soyuz flights that would increase the crew capacity aboard International Space Station. All of those certainly are on the table and under consideration. And as those recommendations come up, we will figure out which options to proceed with so we are not starting from scratch on the day that everything arrives as a report at that time. So we are going to try to be as agile as we can in responding to it, because our objective is to return to safe flight as quickly as we can.

Mr. BELL. Thank you.

Chairman BOEHLERT. The gentleman's time has expired. Mr. Gutknecht, the distinguished Vice Chairman of the Science Committee.

Mr. GUTKNECHT. Thank you very much, Mr. Chairman. And Mr. O'Keefe, thanks for coming here today. These are difficult times. I want to throw out a couple of ideas, issues, and I would like to have you respond to them, and then I have a very specific question.

TANGIBLE BENEFITS OF SPACE RESEARCH

Shortly after the disaster, there was a professor, I believe, from Maryland, and I am sorry, I did not write down his name. But he raised a very troubling question for me. And he asked the question, I think, to the audience what had we really learned in the last five years with all of the money that we have spent that we would not have learned here on Earth? And I think that is a question that NASA is going to have to help us answer. I mean, we have grown a lot of crystals out there, and we have done a lot of experiments. And I know that even some high school students from my hometown have done some experiments. But at the end of the day, it seems to me those are very, very expensive experiments. And I think we have to account to the taxpayers in terms of what we have actually learned in the last five years.

The second point that I think is important, and this all causes us to sort of rethink what we are doing and why, and that is the difference between using human beings in space, manned space flights, and robotics. That has been referred to earlier. Now obviously, when we start doing these deep space probes, we are going to have to use robots, because human beings could not survive the trip. I think in terms of costs versus benefits, I think we need to take a very sober analysis as we go forward, because the one thing we have learned—two things we have learned in the last month, painful lessons, first of all, putting human beings into space is extremely expensive. And the second is, traveling at 16 times the speed of sound is extremely dangerous. And so as we go forward, I think we have an obligation to answer those kinds of questions to our constituents.

And finally, a very specific question, as was mentioned by my colleague from Florida, I am—he and I are among the few, I think, on this committee who also serve on the Budget Committee. And we are currently trying to squeeze about two and a half trillion dollars worth of requests into about a $2.2 trillion budget. And that is not going to be easy. And so in terms of the budget side of it, I want to ask very specifically, part of this committee's responsibility—as part of our responsibility, we must have complete information and records of funding requests from your Agency. Will you provide, for the record, all of NASA's submittals to OMB and the OMB budget guidance and direction to NASA for the Space Shuttle Program and any related accounts since 1997?

Mr. O'KEEFE. Well, I am certainly going to respond to each of the three points you have raised here. The first one is what have we done. Just last night, as a matter of fact, I happened to see a package that impressed me to no end that responds to this question in a way that I hadn't thought of. In the last seven years, over 1,500 journal articles have appeared that are exclusively owing to human space flight research. And a specific activity or comment that was made by Dr. Michael DeBakey, who is the world-renowned heart surgeon, who says, "The human space flight research studies have produced knowledge of tremendous importance that has been of use and practical use in a number of different areas that would not have been possible were it not for these achievements." And he has developed a new heart pump, for example, that he attributes di-

rectly to what research was attained as a result of the human space flight experiences we have had just in the last five years. So there are lots of others, and I will provide those for the record that would summarize——

Mr. GUTKNECHT. Well, Mr. O'Keefe, I think it is good that you provide them for the record at this committee. But it seems to me that one of the functions that NASA probably is going to have to do a better job of in the next—in the coming years is explaining to the American taxpayers, you know. What exactly are they getting in return? Now we know that in the early days we got enormous returns in terms of computer technology, telecommunications, a whole lot of areas that were expanded geometrically because of the space agency. In recent years, we don't see the—that kind of real benefit to the average consumer, and so it is important you share with us, but I think it is even more important now that you share it with the American people.

Mr. O'KEEFE. Point very well taken. I will positively redouble the efforts to work that through. You have made an excellent point.

MATERIAL FOR THE RECORD

National Aeronautics and Space Administration. Office of Aerospace Technology. Commercial Technology Division. *Spinoff 2002.* 2002.

The second issue you raise is humans versus not, our kind of approach to what we do. Again, I think it is not an either or, it is how they compliment each other. And a statistic I saw just the other day that basically translates to about $20 per American is what we spend for human space flight activities. That is what it ultimately costs in terms of the amount of dedication of tax resources or resource efforts toward that. We have got to determine whether that is too high or not. There is no doubt about it and make an assertion of more importantly robbing its expense is the horrific risk that we run by humans being involved. And again, I think that is a case where in the course of human exploration had we not exercised—or had we exercised extreme caution in every case, the Wright Brothers 100 years ago would have never done what they did, and we wouldn't be in air travel today.

So you know, we have to look at this in context, but it is an important one, and I think you raise a seriously important question. And we have to do some deep soul-searching about it.

OMB BUDGET TRACES

The last issue of would we submit where we have been—we are going through the audit trail now trying to resurrect all of the data and information, working with our colleagues within the Administration to ascertain how to respond to that. I will get back to you very shortly on that question. We are working through exactly what the Administration will provide in that context by coordinating with that. We are trying to gather the data now.

Mr. GUTKNECHT. Our staff will follow up with you. Thank you, sir.

MATERIAL FOR THE RECORD

As a general matter, budget requests to OMB are pre-decisional information and, therefore, not released. However, OMB officials are prepared to meet with the Committee to try to address these issues.

In the interim, NASA would like to provide you the enclosed Space Shuttle funding data that has been provided to Committee staff for the past ten years, specifically:

- NASA's Five Year Congressional Budget request history and Final Operating Plan for FY 1994–2004; and,
- Space Shuttle Funding for the years FY 1994–2004.

Similar information has been provided to Senator Ernest Hollings in response to his request and in connection with the February 12, 2003, joint hearing concerning the loss of the orbiter *Columbia*.

RY $ M NOA
No Reimbursements

National Aeronautics and Space Administration
Space Shuttle - Final Operating Plan and Congressional Budget Request History

2/10/2003
6:45 PM

Budget Request Year	FY 93	FY 94	FY 95	FY 96	FY 97	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	5-Year Request TOTAL
1994 Total	**4052.9**	4196.1	4042.7	4201.5	4376.7	4507.5											21325
1995 Total		**3772.3**	3324.0	3295.0	3316.0	3451.0	3568.0										16954
1996 Total			**3155.1**	3232.0	3243.0	3319.0	3336.0	3371.0									16501
1997 Total				**3143.8**	3151.0	3058.0	3032.0	2986.0	3054.0								15281
1998 Total					**2960.9**	2977.0	3019.0	2979.0	3054.0	2978.0							15007
1999 Total						**2912.8**	3059.0	2998.0	3049.0	2989.0	2989.0						15084
2000 Total							**2998.3**	2986.0	3033.0	3014.0	2984.0	2984.0					15001
2001 Total								**2984.4**	3165.7	3307.8	3264.9	3253.2	3169.5				16161
2002 Total									**3118.8**	3283.8	3218.9	3253.3	3213.5	3228.0			16198
2003 Total										**3270.0**	3208.0	3301.0	3305.0	3258.0	3287.0		16359
*2004 Total**												3968.4	4019.8	4064.9	4185.5	4368.9	20608

* - *FY 2004-2008 Budgets are in full cost*
[ ] *Final Operating Plan*

RY $ M NOA
No Reimbursements

National Aeronautics and Space Administration
Space Shuttle Program - Budget History

2/10/2003
6:12 PM

Space Shuttle	FY 94	FY 95	FY 96	FY 97	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08
President's Budget	**4196.1**	**3324.0**	**3231.8**	**3150.9**	**2977.8**	**3059.0**	**2986.2**	**3165.7**	**3283.8**	**3,208.0**	**3,968.4**	**4,019.8**	**4,064.9**	**4,185.5**	**4,368.9**
Delta	-417.4	-168.9	-53.0	0.0	-50.0	-31.0	25.0	-40.0	-5.0						
Appropriated by Congress	**3778.7**	**3155.1**	**3178.8**	**3150.9**	**2927.8**	**3028.0**	**3011.2**	**3125.7**	**3278.8**						
Delta	-6.4	0.0	-35.0	-190.0	-15.0	-29.7	-26.8	-6.9	-8.8						
Final Operating Plan	**3772.3**	**3155.1**	**3143.8**	**2960.9**	**2912.8**	**2998.3**	**2984.4**	**3118.8**	**3270.0**						

FY 1994
- Congress terminated ASRM program and reduced Shuttle program by a total of -$417.4M (-$180.4M for ASRM, -$237.4M for general reduction)
- Agency reduced Shuttle -$20.0M per rescission requirement, offset by received earthquake supplemental of +$13.6M

FY 1995
- Congress assigned -$168.9M general reduction to Human Space Flight- Shuttle took all of it

FY 1996
- Congress reduced -$53M for Yellow Creek Facility at Iuka, MS savings
- Agency transferred -$30M to International Space Station and -$5M to Payload Utilization and Operations

FY 1997
- Agency transferred -$190M to ISS and RPA

FY 1998
- Congress transferred -$50.0M to ISS and related activities per agency request
- Agency transferred -$15.0M to ISS by deferring two flights and reducing agency overhead on program

FY 1999
- Congress reduced Shuttle -$31.0M per agency request so it could fund Mission Support requirements for personnel and Space Communication services
- Agency added back +$2.3M from ISS to previous agency request; reduced Shuttle -$32.0M by deferring two flights and transferring funds to ISS

RY $ M NOA
No Reimbursements

National Aeronautics and Space Administration
Space Shuttle Program - Budget History

2/10/2003
6:12 PM

FY 2000
- Congress added to Shuttle +$25.0M for additional supportability upgrades, also $25.0M transferred within Shuttle from Operations to Upgrades
- Congress specified earmark of [$40.0M] for R2 mission, without adding funds to Shuttle budget
- Agency reduced Shuttle -$11.5M per rescission requirement in P.L. 106-113, transferred -$15.3M to ISS for research utilization

FY 2001
- Congress reduced Shuttle -$40.0M for Mars Initiative per agency request
- Agency reduced Shuttle -$6.9M per rescission requirement in revised operating plan

FY 2002
- Congress reduced Shuttle -$50.0M for Electric APU cancellation and added +$20M for Shuttle Upgrades and +$25M for repair of VAB
- Agency transferred -$7.6M to fund agency requirements at HQ and -$1.2M per rescission requirement in revised operating plan

FY 2003
- No appropriation received yet

FY 2004 - 2008
- Program Budget in Full Cost, assumed flight rate of five per year

Chairman BOEHLERT. Thank you. The gentleman's time has expired. Well, there is some good news from the briefing from Secretary Ridge on Homeland Security. The Homeland terrorism alert has been downgraded from Code Orange to Code Yellow. The briefing is ongoing, and as you might suspect, it is dealing with some very important subject matter. So at least there are some good news to put on the table.

SPACE SHUTTLE ACCIDENT INVESTIGATION—E-MAIL EXCHANGES

I understand, Mr. Administrator, that in my absence there was a little bit of excitement generated in an exchange with Mr. Weiner. I understand in his enthusiasm he went a little far in comparing this to the *Challenger* situation. There were experts in that case who were clearly saying you should not—NASA should not launch this vehicle. Here we have the much more ambiguous situation of engineering—engineers speculating about a wide variety of possible problems that they themselves characterize as unlikely but worth considering. And it is not clear at all what the remedy might be. I am not suggesting that these e-mails weren't important or shouldn't be heeded. I am suggesting that we need to avoid simplistic comparisons, and we need to investigate how the e-mail traffic from this mission may have differed from that of other missions. And as the Administrator has said, we need to look hard at whether judgment calls were being made at the appropriate level in the Agency with the appropriate amount of information.

I think it is a little bit premature to do any finger pointing at this stage. We are all searching for the same sometimes elusive facts. So Mr. O'Keefe, do you feel at this point that any of the released e-mails should have been seen by you at the time they were written?

Mr. O'KEEFE. Again, that would be an extraordinary volume. And given the circumstances of my limited intellectual capacity, I am not sure I could have digested all of it. I have seen, just in the course of the last three weeks during the course of operations—again, everybody is expected to step up in these cases during an operational activity. And it appears for all of the world that that exchange was going on. And exactly the right kind of scenario analysis and simulation of cases does not appear to have been something that was a lingering question. There was resolution to each of these points. And again, that is exactly the right kind of commentary that ought to be going on.

As it pertains to spirit of exchange in your absence or while you were here, I can assure you, every exchange has been spirited, and I have enjoyed every one of them.

Chairman BOEHLERT. Well, let me ask you, what was the highest level in which the e-mails were reviewed? And are you convinced, in looking back, and hindsight is always 20/20, that it was the appropriate level for decision-making?

Mr. O'KEEFE. That is a good question. It—on this particular circumstance, which again narrowly deals with the scenario and simulation of the question of what do you do on landing with one flat tire or two flat tires, as I understand the nature of the exchange, and what could lead to these problems leading up to that landing?

That was vetted all the way through to the point of some very senior folks at Langley as well as at Johnson. It was at the mission operation directorate level that was specific activity engaged in. And at one point, even raised, I think, the center director at Langley Research Center. And I was just down at Langley two days ago to discuss with all of the—our colleagues there how we are working through the investigation and did have an opportunity to exchange a bit with some of the folks who were engaged in this particular dialogue as it pertains to the landing options that might have otherwise occurred. And they were all of a mind that, indeed, that discussion that was going on was exactly the kind of discussion that goes on for every kind of mission, and it is the nature of the same debate, and that it was resolved at the appropriate levels.

I want to reserve on that question until I see the Gehman recommendations as to whether or not that was the appropriate level to deal with. And I really want to—I have got to look at this very, very carefully. But in this particular case, the folks who participated were pretty senior at lots of levels within the two centers that were engaged in the activity and were aware of the activities that were going on and were making judgments about what they thought the preponderance of evidence would suggest as a safety of flight consideration. That is—you know, we can argue with the nature of the judgment and whether it should have been different or not, but the question of whether it was iterated and resolved as they worked through it, the benefit of a lot of knowledge was exchanged. That is very, very clear.

Chairman BOEHLERT. So at this point, you feel that the appropriate level did deal with e-mails and that they should not have come to the Administrator at the time, it was not necessary in view of all of the other responsibilities?

Mr. O'KEEFE. Indeed. But again, I will be guided by the Gehman Board's view of exactly what is the appropriate call in those circumstances. It sure appears as though the right discussions at the right levels and resolving it at the right circumstances were engaged and that indeed the resolution was no safety of flight consideration. And that was what was reported up the chain throughout the course of the operation on several different occasions of having done their jobs and worked through it professionally, diligently, and accountably. They reached conclusions based on the preponderance of evidence of what compromise to safety of flight would be involved and so advised everyone throughout that chain.

So you know, again, as we work through this to the extent there is a different systemic challenge or management challenge that would be identified, I am going to be guided by the Gehman Board's view of that question.

Chairman BOEHLERT. Thank you very much. And as we all will be, and that is why I think it is particularly important that we continue that besides the independent nature of the Gehman Commission.

Mr. O'KEEFE. Indeed.

Chairman BOEHLERT. In that regard, let me turn now to Ms. Woolsey.

Ms. WOOLSEY. Thank you, Mr. Chairman. Thank you, Mr. O'Keefe. I believe, through this process since the tragedy that you

have played a great role in helping our country and our nation through this tragedy and with a lack of defensiveness that I really respect.

Mr. O'KEEFE. Thank you very much.

Ms. WOOLSEY. But you know what, we are in a new place right now with this e-mail. And I think there are questions the public wants answered. I don't think that we can pacify them now that they have read what the staff was questioning. And I can say just for myself that supporting the NASA budget is going to depend on feeling absolutely sure that we have gotten real answers to those questions that were asked and that came out of that e-mail.

I mean, I think that—I mean, could the shuttle crew have survived had they known ahead of time that maybe they should abort the mission and come back before that area of concern was stressed through the entire mission? And could they have—I mean, I don't know the answers to these. I wouldn't even begin to know, but I know if I don't, the public doesn't, and they want to know these things. Could the crew have been able to repair the area at the space station or something? Could the crew have prepared to escape upon return if they had known in time? The public has to know this, and they want to know it before, and I want to know it before we authorize another budget.

Mr. O'KEEFE. Absolutely. You know, there is no question. We really have to work through this and be responsive. We will be accountable. We will be absolutely honest about what we think of the assessments here and any mistakes or judgment calls made as we work through this is—will be guided by the Gehman Board's recommendations and findings in those cases, so there is no question. In this case—particular case, and again, this is, in one aspect, a many, many, many, many different correspondences that went on during the course of operations and everything that led up to it, dealt very specifically with the issue of whether the orbiter could land on a flat tire or not, or two flat tires, or without the gear being up or down.

That is the kind of debate and discussion we want to see go on. Well, I want to encourage and want to keep folks feeling like they can do in the course of this. And my commitment in this particular case to all of our colleagues around the Agency is that is precisely the kind of discussion that needs to go on, and we will, indeed, be accountable for that answer.

Could they have responded to something? Well, to the extent that there is—again, it was a determination made. The safety of flight consideration was supported by the evidence involved. And a judgment call is made that said it was the problem. The crew would have been advised. Any number of different scenarios would have been activated, but the fact of the matter is, on all of the 4,000 onboard centers on—sensors on *Columbia,* none of them indicated that there was a problem in this particular area. And until 8:52 that morning, no failure was detected. So as a consequence, a lot of scenarios and what ifs were going on, but no evidence to support that by a sensor suggesting a problem or anything else. Now as the information is certainly coming out at this juncture, as we are continuing to make sure we look at every single scrap of anything, we will be accountable for that. We will, indeed, find out what the

cause was driven by their findings, and we will make corrections to assure that within the limits of human frailty, this never happens again.

Ms. WOOLSEY. Well, okay. I appreciate that, because the public wants—is more interested in what action was or was not taken, what prevention in the future versus participation. We need to know that.

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

NASA WORKFORCE

Ms. WOOLSEY. Okay. Now I want to go off on another subject, and the subject is who is going to be our workers in the future for the space program with everybody aging? I know our Chairman is—has legislation and—to sure up our work force, but one with the aging population of your workers and two with, you know, the challenge of what has just happened and possibly people won't be coming to NASA to go to work. What are you doing about that?

Mr. O'KEEFE. Well, thank you.

Ms. WOOLSEY. I mean, is it a problem?

Mr. O'KEEFE. It is. It is an issue that we are most concerned about, and indeed, this is a maturing work force. I am 47 years old. I am the average age of the Agency.

Ms. WOOLSEY. You are a baby.

Mr. O'KEEFE. I know I look a lot older than that. But that is my—but as a consequence it is, you know, a real challenge when you look at and you really shred the information of what the maturity level, if you will, of the work force is at this juncture is we have three times as many folks who were scientists, engineers, and technologists who are over 60 as we have under 30.

And so as a consequence, the better part of a quarter, approaching a third, of our work force will be eligible to retire in the next five years. Last June, we submitted the Congress—the President initiated legislation to look at a whole range of personnel authorities to take the best practices that had been enacted by Congress and implemented by agencies of the Federal Government in the last decade and utilizing each of those best practices to give those authorities to NASA to recruit, retain, and to continue to develop the opportunities for engineering, scientific, and technology related fields to encourage to come to NASA. Every opportunity we have, and that is one of the reasons education is a dominant part of our mission objectives now to inspire that next generation of explorers that we have just adopted as a way to look at this, is to really go out there and actively encourage interest in what we do. And there is no question the interest level is high. We need to get about the business of not only recruiting, but also retaining and bringing in mid-level entry of folks within other experiences. All of those opportunities the Chairman has very impressively sponsored as part of his effort to help us move forward, get those tools and be able to deal with what I think is a looming set of issues. And we are not there yet, but we certainly have an opportunity to shape and effect that outcome in the years ahead if we do this diligently. And the Chairman's sponsorship has been most helpful.

Ms. WOOLSEY. Right.

Chairman BOEHLERT. The gentlelady's time has expired. The gentleman from Oklahoma.

ORBITAL SPACE PLANE

Mr. LUCAS. Thank you, Mr. Chairman and Mr. Director. I know that we focused a great deal on the shuttle here, but still, it is a 30-year-old design, flying people in the back of what are, in effect, ballistic missiles, a 40-year-old concept. In your budget request, you request $550 million for this coming year on the Orbital Space Plane concept. And if you could answer the following questions in whatever order you choose to: what do we, as the U.S. Government and American taxpayers, get for that $550 million this year; if this effort is successful, and I hope it would be, how long before we will have an operational Orbital Space Plane; what would the total cost be when we get to that point; and will it be, maybe the science for single stage is not achievable, will it be a single-stage, a two-stage, or is it still going to require those ballistic missiles?

Mr. O'KEEFE. Okay. For $550 million in this coming year, as well as in each successive year hereafter, what it primarily covers is the cost of technology demonstration of the X–37 right now, which is under development and in production. It is a physical asset that you can go put your hands on in Palmdale, California that the Boeing folks are working on. It is a technology demonstrator of the maneuverability characteristics we seek in the Orbital Space Plane.

What is the next stage in this and what part of that 550 million covers as well is the cost to design and select a specific set of characteristics and work through all of those requirements on the part of several contractors. So the ultimate objective we select is not just a tech demo, but an operational asset. And so that is partly what that covers as well.

When operational? The current plan is we seek to do that by the end of this decade. Part of what's been a dialogue here today is as our efforts in working with the Orbital Space Plane Program and the Aeronautics Technology's enterprise within NASA to see if we can find differing schedules to accelerate, potentially look at what do we take in order to produce that particular asset sooner.

Total cost? Don't know until we select what the competitive design is. There are at least three or four different approaches that could be used. Some have wings, some don't. There are all kinds of different methods that contractors are looking at and will be looking to respond to that will then give us the answer to that cost. But before we make that decision, we will—the Congress will know what that cost estimate is of the general perimeters of a view of where we go before we make a contract award. And that is partly what I think Congressman Rohrabacher was referring to a little bit earlier in terms of when are we going to get to a stage that we will understand that. And that—the answer to that is within the next 12 to 18 months of selecting what design you would ultimately select to go that route, and that will give a cost number.

Will it be single or multiple stage? The initial idea is to launch it off an expendable vehicle. So yes, indeed. It is not a reusable launch vehicle asset that would not use chemical propellant. That is no question. It is going to be still tethered to the exciting eight and a half minutes it takes to get in the orbit that is very typical

of the way we have done business in the past. And there is no doubt about it. It is tethered to that, because the objective of the Orbital Space Plane is primarily to test its maneuverability, its durability features, its flexibility on orbit.

The next generation launch technology's approach that we have also included and is funded—or proposed, subject to your approval, is an approach to look at what it would take to get out of the expendable launch vehicle business and start looking at reusable launch vehicles that can launch and land just like aircraft do. That is a ways away. We tried to go down that road a few years ago, I am advised, with the X-33 program, and found that it required a suspension of the laws of physics in order to accomplish the task. We don't know how to do it yet, so we are trying to beat each of these technical obstacles one at a time in order to achieve that ultimate objective down the road.

Mr. LUCAS. Thank you, Mr. Chairman.

Chairman BOEHLERT. Thank you.

Mr. O'KEEFE. Thank you, Congressman.

Chairman BOEHLERT. Mr. Matheson.

LIMITED SUPPLIERS

Mr. MATHESON. Thank you, Mr. Chairman. And thank you, Mr. O'Keefe, for giving us so much time today. I just have a couple of questions I wanted to run past you. Representative Woolsey raised the issue about work force issues and—within NASA, and I guess another component that would be among your suppliers, for example, with the space shuttle operations being suspended for the time being. There are many suppliers, such as American Pacific, that produces the chemical for the shuttle solid rocket motors. And there is a question that they are going to be able to sustain their work force during this period of suspension of operation. It is my understanding they are the only supplier of this material within the United States.

Has NASA been able to give some thought to anything to address these companies that may be facing these layoffs that may be part of your critical supply chain and issues we can do to make sure we don't run into problems with that?

Mr. O'KEEFE. Sure. Would—as a matter of fact, this is one of several—I appreciate your point. We are faced with a very limited supply, because you know, it is not a large scale, you know, production run of anything that we are engaged in. And throughout NASA, there are—we aren't a manufacturing house. I mean, there are single digits of anything. You know, we don't do anything by volume. And as a consequence, it is a singular stand-alone set of programs each and every time.

The objective really I will look at for the industrial base is to try to identify where those long poles in the tent are, for example, of supplier requirements. We are just beginning to get down that road to look at what that may be, but we again remain very optimistic that if we can find and if the findings are released by the independent Gehman Board here in the time ahead that we can determine what those corrections are, get back to safe flight. And only when we are assured that those operational corrections are sufficient to guarantee, within the limits of human frailty, our ability

to get back to safe flight. I am very optimistic we can still attain that. To the extent we can't, the—again, the industrial based issues we have got to look to were being guided by the four primary space flight centers to look at what those initial requirements are that may be perishable in those cases. And so we are starting down that road now to start thinking about what those are, including the very case you raise as well.

Mr. MATHESON. Well, I am glad to hear that, because I do think that is just an issue that deserves some good attention.

INTEGRATED SPACE TRANSPORTATION PLAN

One more question. I know you have talked about this a lot today. But just real quick, I know last November the integrated space transportation plan that NASA laid out in its budget amendment for the fiscal year 2003 NASA budget, it outlined an approach to ensuring the country has human access to space in the near-term with what was going to be number one, a safer and more efficient space shuttle, number two, an orbital space plane to support the space station, and number three, a long-term plan for developing a revolutionary launch system for the future with next generation launch technology and with that program. So the question that I would ask you are—is—at this point, do you interpret that is the Orbital Space Plane intended to be a compliment to the shuttle by giving alternative crew access to and from the space station or is it intended to replace the shuttle? And secondly, is the Orbital Space Plane going to be using existing technologies, or is it going to require continued development of new technologies, and if so, what is your sense? Is it going to delay development over a period of time, potential delays? I am just wondering how you see those programs meshing with each other in the near-term.

Mr. O'KEEFE. Sure. Thank you for a very important question. And I think we have really done a lot of soul-searching leading to this proposal that was submitted first, as you correctly cite, as part of the November budget amendment that the President submitted and now reaffirmed as part of our fiscal year 2004 proposal that the President has submitted along with the '04 budget. And that is that indeed it is a compliment to the space shuttle effort, specifically as a way to think about how we can do dynamic, very flexible, extremely maneuverable crew transfer requirements that would bring folks back and forth at International Space Station as, again, flexibly as we can, because among the things the shuttle is, being flexible and dynamic in terms of its ability to launch on near no notice is not one of its characteristics.

It takes a lot of time, a lot of energy, a lot of effort, and indeed, 30 days before launch, we have got to roll out the orbiter and make sure everything checks out. It goes through an exhaustive effort. It is not a flexible asset in that regard. So using it as a remarkable cargo and asset carrying capability, given the fact that it is the—if the payload bay is what we need in order to continue building the International Space Station. We can't do it—as it has been pointed out here in today's discussion, we can't do it any other way. There is no other asset we have in order to launch and bring to space station the components, the modules, the capabilities, the

laboratory capabilities for science and research in any other method. So we have got to have that capability to carry that.

ORBITAL SPACE PLANE REQUIREMENTS

But in terms of crew capability, the Orbital Space Plane can easily supplement for that purpose so we can, you know, devolve more toward cargo transportation requirements for shuttle and more for crew transfer requirements for the Orbital Space Plane. The aspect that we are looking to, and again, this is in part the discussion with Mr. Lucas here a moment ago, is we are looking to identify a couple of technical limits that we currently have to live with, which is maneuverability and the capacity to launch on a little more of a—on a near no notice that would give us some more dynamic flexibility in scheduling.

Those are the kinds of things we seek to overcome with the Orbital Space Plane. So rather than try and look at a whole range of different technical limitations, we are trying to narrow it to a couple and achieve maneuverability purposes in order to get some flexibility in the asset so it has some power generation capability, which the shuttle currently does not while it is on orbit to any really great degree of adjusting its capabilities and to have a capacity in order to assure transfer back and forth on as immediate a notice as we possibly can to assure the safety of not only the crew aboard but also on International Space Station.

So we are trying to narrow those purposes so we are not trying to have an asset that does all things for all people. Instead, you beat those technical limits one at a time and do it in a very disciplined way.

Chairman BOEHLERT. Thank you

Mr. O'KEEFE. Thank you.

Chairman BOEHLERT. The gentleman's time has expired. Dr. Gingrey.

Mr. O'KEEFE. I appreciate the thoughtful questions.

AERONAUTICS RESEARCH AND DEVELOPMENT

Dr. GINGREY. Thank you, Mr. Chairman. Mr. O'Keefe, thank you for your patience and candor in responding to these very important questions. The Committee has some concern over aeronautic R&D funding cuts. You know, the Administration's fiscal year 2004 budget request finances aeronautics technology program is $959 million. Once a core program within NASA, the Administration plans to cut funding for this program by five percent over the next five years and this just sort of exacerbates a 10-year period of cuts. Today, NASA is only spending half of what it expended in 1998 on aeronautics, and these needs were highlighted in the final report of the commission on the future of the United States aerospace industry, a congressionally created commission chaired by former Science Committee Chairman, Bob Walker.

And this report concluded, "As we approach the 100th anniversary of powered flight, the Commission urges the President and Congress to recognize a pressing national need and powerful opportunity and act now to create a 21st century air transportation system." The House Science Committee plans two hearing and legisla-

tion on these aeronautic R&D issues over the next couple of months. Now I have got three questions pertaining to that.

Given the Aerospace Commission's findings, what is the explanation for cutting aeronautics funding? The second question, what is NASA going to do to implement the recommendations of the Aerospace Commission? And finally, Mr. O'Keefe, how did you—how do you view NASA's role to aid the Federal Aviation Administration, the FAA, and U.S. industry to develop the next generation modernized air traffic system and technology for quiet aircraft?

Mr. O'KEEFE. Sure. Thank you very much for those questions. The—as it pertains to the Commission's findings, you are absolutely right. Their view is that we need to look at a robust aeronautics capability in fiscal year 2004, 960 or $959 million is what has been proposed. For the out years thereafter, that has relationship to the last question you raised, which is we are currently working with Marion Blakey at the Federal Aviation Administration and the Department of Transportation and the Defense Department to look at how we might look at not only quiet aircraft technology but also aerospace management efforts, the security and safety kinds of issues on aeronautics and aviation. And so we are trying to wrap all of those together, and I can safely predict they will be making adjustments to those out years before they are actually presented to you for consideration for an annual appropriation.

So at this juncture, that is a baseline, if you will. It goes nowhere but adjusted after we complete these efforts with the FAA and the Department of Transportation. And again, I take the findings and recommendations of the Walker Commission very seriously and ones that we want to now reconcile relative to programs and plans on aerospace management, aviation security and safety, and quiet aircraft technology to look at those in coordination with Defense, DOT, FAA particularly. And Marion Blakey and I are working tighter very closely to develop as part of the '05 budget submission on what that may take.

Dr. GINGREY. Thank you.

Mr. O'KEEFE. Thank you, Congressman.

Chairman BOEHLERT. Mr. Miller.

Mr. MILLER. Thank you. Mr. O'Keefe, there have been several questions today about our return on investment whether it is space exploration, human space travel, or other space exploration is really worth it. I support human space travel and space exploration for its own sake. I still feel an open-mouthed wonder at the idea of space exploration, and I quickly become 49 going on 9 when I think of human space travel.

HUMAN RESEARCH INITIATIVE

But when I am forced to offer grown-up reasons for supporting space exploration, they are what you offered a few minutes ago and what Dr. DeBakey offered, and that is we have developed technologies that have practical commercial applications, unintended but happy results from research for another purpose. Is that still a purpose, a part of NASA's mission?

Mr. O'KEEFE. Absolutely. Yes, sir. Let me give you another example. What is in this budget now for your consideration is the human research initiative that I talked about in the opening state-

ment is the better part of about $400 million worth of effort dedicated to trying to determine the challenges to human endurance in space flight. Now one of the challenges—two of the challenges that we confront on every expedition mission on International Space Station is a degeneration of muscle mass and bone loss. It is an accelerated degeneration. It is one that is roughly on the order of 30 percent muscle mass loss over a span of four to six months on orbit is what most astronauts experience on International Space Station for that duration. And they lose up to 10 percent of bone mass loss. So it is a very accelerated degeneration effort. If we could figure out how to arrest that, its applications for the rest of us earthbound folks is rather dramatic——

Mr. MILLER. Right.

Mr. O'KEEFE [continuing]. Because it would avoid challenges with osteoporosis, hip replacements, you name it. If we can figure out how to deal with this on a much more gradual basis on Earth, we could apply those same principles, and it is imperative to do so to arrest the rapid degeneration that occurs on most astronauts there. So that is just one example of the kinds of breakthroughs, I think, that will help long-term duration space flight necessary for any exploration objectives but also has an immediate near-term benefit to the millions of us here who regrettably, as a consequence of aging, will encounter these kinds of challenges. And if we can find out solutions to that, they have help and application to us here.

Mr. MILLER. I have some questions specifically about commercial applications of NASA's technology in research. Mr. O'Keefe, about how much does NASA now get from licensing agreements for technologies that have been the result of a commercial application for—from NASA's research.

Mr. O'KEEFE. Oh, I don't know. Let me provide that for the record. I just flat don't know the answer to that.

MATERIAL FOR THE RECORD

The following royalties and fees were received by NASA (excluding JPL/California Institute of Technology) from commercial patent and copyright licenses:

FY 2001: $1,007,740
FY 2002: $1,081,170

Mr. MILLER. Okay. In your '04 budget, NASA's proposed budget, there is a new program called Enterprise Engine. Could you describe what that program is, what its purpose is, how it works?

Mr. O'KEEFE. Yes. Let me search my mind here. The objective there is to look at new engine technologies that is being—I believe in this particular case it is being conducted at the Glenn Research Center in Cleveland, Ohio. Part of the effort is looking at a range of different fuel cell capabilities and others. I am sorry. Am I not responding to the question right?

Mr. MILLER. I don't think that is the purpose. It is...

Mr. O'KEEFE. I apologize. Let me answer it for the record then, because I don't know then.

Mr. MILLER. All right. I don't understand, and I am sincerely asking questions to get information.

Mr. O'KEEFE. Sure.

Mr. MILLER. But actually, what you have just said is contrary to all of the information that I have gotten before about what Enterprise Engine is.

Mr. O'KEEFE. Okay. You know, I freely confess that it is likely that I got it wrong. And so let me provide it for the record and not wing it. Yeah, I have got a note that says it is a commercialization effort. That is about as illuminating as—you know, I don't know. But I don't know. And let me not wing it. I have got it wrong——

Mr. MILLER. Okay.

Mr. O'KEEFE [continuing]. And I will provide it for the record.

MATERIAL FOR THE RECORD

The Enterprise Engine is a pilot project to establish partnerships with private sector innovators and investors to sponsor dual-use technologies to meet NASA's future mission and technology needs. The Enterprise Engine is intended to attract new partners to NASA—innovators and investors that have not traditionally conducted business with NASA. This new concept entails partnerships at the beginning of the process of technology development, taking advantage of existing technologies or the technological capability that exists in the private sector. As part of the new emphasis on technologies that directly benefit NASA's missions, this outside capability would then be channeled to meet NASA's technological needs.

Mr. MILLER. I probably ought to direct the rest of my questions to this fellow standing right over—sitting right over here. That is what he gets for sending notes up, so you can have that one back. The budget for '04 also terminates——

Mr. O'KEEFE. I would be delighted to let him sit here and let me leave. Excuse me, Congressman. I am sorry.

COMMERCIAL TECHNOLOGY TRANSFER

Mr. MILLER. The budget also terminates all of the funding for the commercial technology program. How will you do that instead?

Mr. O'KEEFE. Well, there—it is not all of it. There is a—the aspects of the commercial technology transfer that are uniquely—can only be carried out by NASA are the things we are continuing. There are a couple of efforts on a national technology tech transfer center and a few other things that are still retained there. We are also looking to—is to utilize the capacity on the part of industry, universities, others to pick up that tech transfer, because in a lot of ways, the last thing we are is really competent at figuring out what commercial applications could come from something. Industry is good at that. Universities are good at that.

And so part of our task ought to be to make that information available to figure out how they can then apply it rather than us, the government, public sector trying to anticipate how you can use something for a commercial application. We are singularly unqualified to do that kind of activity, so we are trying to look to industry and universities to partner with us to assume that role in a more dynamic way.

Chairman BOEHLERT. The gentleman's time has expired. Thank you very much. Ms. Jackson Lee.

Ms. JACKSON LEE. Thank you very much, Mr. Chairman. Let me as well, Mr. Administrator, add certainly our community's appreciation to NASA in the aftermath and particularly the attention given to the families. And as I know, the attention is still given to the families. I think whatever we do in this session of Congress

that relates to NASA should be in tribute and respect to their enormous loss——

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

Ms. JACKSON LEE [continuing]. And to the sacrifice that was made by those who lost their life. I might want to mention General Howell, who is our administrator or our director at NASA Johnson. I particularly want to compliment him and his staff for what they continue to do.

Pointedly, let me just ask a question barring the reflection of the budget. Does this Administration have any immediate perspective or in the future plans to scrap the human space flight human space shuttle?

Mr. O'KEEFE. No.

Ms. JACKSON LEE. I think it is important, because the rumors abound, and even though there is a projected budget, you are telling me that the President does not intend to eliminate the human space shuttle?

Mr. O'KEEFE. Absolutely not.

Ms. JACKSON LEE. With that in mind, let me focus on what I think is enormously important. I have noted that you have listened and NASA has expanded the investigatory board. The accident board is reviewing, but I believe expansion would require some additional consideration that would bring some enhanced diversity and sensitivity to those who have been astronauts. And in keeping with that spirit, I would suggest to you that it could be expanded. Dr. Bernard Harris is a part of our community, and we are well aware of retired General—Marine General Bolden, who you have great respect for. And I would like to converse with you on that point about how we can ensure that we are reaching out and bring a number of sensitivities to the table that I think might be important.

I want to pursue very briefly the question of the e-mail, but not so much. That is going to be part of the investigation. It saddens us, but we need to find out the facts. But what I do want to pursue is the question of the enormous amount, issues that I have raised of privatization that have occurred over the years that we come to acknowledge. I expect to call all of the corporations that have now taken up responsibilities that we used to have as NASA staff, government staff, up into my office and ask them about their training, how long the employees have been in place, and I would ask the Chairman to consider that as a hearing to have the questions asked about the engineers, how long they have been in place, what do they know and what do they not know. What is your assessment of the impact of privatization and the tenure of staff on the safety questions that we are now dealing with and the tragedy that we are now dealing with?

And let me just follow up so that you can have the time to answer to be able to ask the question dealing with crew survivability. I think we have been lacking in that kind of research, and I would like to know what we can do to provide funding focused specifically on crew survivability. I think we have been lacking in the 17 years since *Challenger* and now, of course, we face another challenge with respect to this particular tragedy that we faced over the last month. And I would appreciate your question—your answers.

MATERIAL FOR THE RECORD

The evaluation of crew escape systems technology continues. At the March 2003, Space Shuttle Service Life Extension Program (SLEP) Summit, a study on Crew Survivability was proposed. The Space Flight Leadership Council authorized the initiation of that study. The focus of the study is to define the benefits, cost, schedule and potential impacts of adding ejection seats to the flight deck of the Orbiter. We are also collecting and summarizing previous survivability studies for review by senior management. Results of the study will be presented to senior management at the next SLEP Summit, which is tentatively scheduled for February 2004. It should not be noted, however, that no crew escape system has been demonstrated as viable above 85,000 feet or above Mach 3.

SPACE SHUTTLE PRIVATIZATION

Mr. O'KEEFE. Indeed. Thank you very much. On the privatization consequences or the fact that it is—the activities for launch as well as on orbit operational activities are conducted by contractors or individuals who are not United States government employees. The data would suggest over the course of the last decade that in the course of that time in which the transitions occurred that the incident of on launch—or pre-launch anomalies as well as on-orbit deficiencies or problems or whatever else have actually gone down. So the safety margins or capabilities have actually appeared to have improved during the course of that time based on the data. And again, we will provide that for you in greater detail, but it is a—it just seems to be a pattern here that would suggest an improvement in those safety considerations in the course of that time.

Nonetheless, something went wrong on this flight. Whether it is attributable to the safety factors or not is something we will learn from the Gehman Board's findings. And if it is, that is what we are going to correct. But all of the information would seem to suggest this is not as a consequence—a transition one way or the other.

MATERIAL FOR THE RECORD

Refer to the publication, "The Space Shuttle's Second Decade: America's Best Gets Better;" Website address: http://spaceflight.nasa.gov/shuttle/seconddecade

The second point that I think is important in this area, too, is a difference of what appears to be, again, given my limited tenure of just a year and a month, it is restricted to examination of the prior efforts, appears to be a transition from a quality-control approach to a quality-assurance approach. That is a modern, very contemporary transition that has occurred in lots of different things we do as human beings over the course of this last decade in lots of different enterprises and professional activities, which is to get away from the checkers checking the checkers to one in which we improve the process to assure that systemically there is a reduction of risk. And that is a more modern, contemporary, management approach that seems to have paid dividends in this particular case. But again, we will be guided by the independent *Columbia* Accident Investigation Board's findings as to whether this may have been a contributing cause or not.

Chairman BOEHLERT. The gentlelady's time has expired. Ms. Johnson.

Ms. JOHNSON. Thank you, Mr. Chairman. I—this is the first time I have been invisible for—in a long, long time to be here all of this time when everybody that came in after me gets called on first. So

I want to make sure the record reflects that I don't like it, and the——

Chairman BOEHLERT. Make sure the record also reflects that the majority gets the list from the minority, and we follow the list to the letter. There is no favoritism played in this committee. We try to be fair to all concerned.

Ms. JOHNSON. Well, this has nothing to do with party.

Chairman BOEHLERT. The gentlelady may proceed for five minutes.

Ms. JOHNSON. Yes. Thank you. This has nothing to do with party. It has to do with whether or not staff is sufficient. I would like to ask unanimous consent to file my statement for the opening and apologize for having another Committee where I had to the same thing before coming, but I did get here around 11 o'clock.

The—Mr. O'Keefe, I appreciate you staying all of this time and not losing your cool and all of that. And I have observed, because this was obviously very disturbing to someone whose family called me before it came on CNN to tell me about a boom down in Dallas.

SPACE SHUTTLE OBSOLESCENCE

But there are a number of things that I have some concerns about. First, the obsolete equipment and parts and the—with this shuttle being in operation since 1981 and planned on being in until 2020 with the advances that technology and everything else has made in this complex system, it would seem to me that ought to give you some kind of indication it might have—and then the computers have not been upgraded since—only once, and that was '88 and '89. Now maybe something about all of this I don't understand, and I would like some comments on it.

The space exploration program research obviously has been one of the most successful in our Nation with all of the products and services of which we have gotten. And it is costly. Most research is costly, but I think that it is certainly returned on the investment. But I want an explanation as to why this—the average person reading this would be shocked that something this important, this risky for human survival would have technology of which the research has been responsible for producing, and you have some of the most antiquated technology that I have heard of recently. It seemed to me that the shuttle just started falling apart. And it might be because of the age of it and—but I would like you to comment on that.

Mr. O'KEEFE. Yes, ma'am. Thank you very much. I read some of the same articles as well, and I am mystified, because this characterizes an asset that I am not familiar with. The shuttle orbiters go through an exhaustive effort every eight to ten flights called an orbiter major modification program. And as a consequence, it—what is conducted in that is a virtual tear down of the entire asset every eight to ten flights in which you bring it down to the bare air frame and then reassemble it to assure that all of the systems are modernized and upgraded and that the capabilities for upgrades are incorporated into each of the orbiters as they go through this process. So roughly every, you know, four years, you are seeing every one of those. There is always one orbiter in that process. Discovery is currently in that process. And what it will come out as

is not a brand new, but a close to restored condition asset that we can make it.

Columbia had gone through a $160 million, 24-month major modification effort in late '01 is when it delivered. Its first flight was in March of '02, and unfortunately STS–107 was its second flight after that OMM, but it was an upgraded asset just a little over a year before. So the capabilities and the equipment, it is as modern as it can be permitted to be.

Now the second point is that one of the things that we don't want to do is test out new things on the shuttle before we fully understand what the characteristics of failure might be. And so, as a consequence, any upgrade that is incorporated here really has to be rigorously tested before we incorporate it into the shuttle program, because the last thing you need is an on-orbit failure, which is clearly what seemed to have happened here somewhere. Something happened, and we are going to find out what it was, but it wasn't for a lack of continually reviewing the testing involved and making sure that the systems are upgraded.

Nonetheless, if the *Columbia* Accident Investigation Board and that—in the Board's view is that the age of the asset, the technology or whatever is deficient, that is what is going to guide our future view of exactly what it is going to take to return to flight or not. So inasmuch as these trends may be something I look at and say I am not sure how to reconcile them, it—nonetheless, we are going to be guided in terms of what occurs here by that independent judgment of the *Columbia* Accident Investigation Board. And if that is one of their findings, that is what we are going to be dealing with and responding to.

Chairman BOEHLERT. The gentlelady's time has expired. Mr. Larson.

AERONAUTICS RESEARCH & DEVELOPMENT

Mr. LARSON. Thank you, Mr. Chairman, for your patience, and thank you, Mr. O'Keefe, as well for the endurance test here this morning. Let me add to the course of those that have expressed the very thoughtful manner in which you have handled a very difficult situation, especially for the NASA family and to the fact that astronauts and their families and for the straightforward manner that you have held up during considerable questions from Congress.

Having said that, let me cut right to the straightforward response I am looking for, and I wish to associate myself with the questioning remarks of Mr.—Representative Gingrey, because it is very disappointing to me, as a person who is entirely supportive of the space program to see that the aeronautics portion of the budget gets cut again. The budget gets cut, it is orphaned, and if you really look at the R&D portion of that budget and while we are projecting a five percent cut, when you look at the institutional costs that are involved in this, in reality, it is probably more than that for R&D. This is when we are facing European vision 20/20, when we are experiencing all kinds of problems with our aeronautical industry here in the country. And we seem to be able to find money within the NASA budget for other activities, but we are cutting out a core activity and mission of NASA. We have the Walker Commission, the President's Commission on the future of aerospace and in-

dustry coming forward with a report, and it just seems to me, especially, like many people in this room, hailing from districts that focus on aeronautics and given the current plight of that industry that we really have to rectify this and turn this around. And otherwise, people like myself who are supportive of the space program, are going to have to rank order our priorities in terms of where we think those dollars should go.

Mr. O'KEEFE. Yes, sir. Now I appreciate your comments and the sentiment as well. The budget before you for fiscal year 2004 is $959 million, which is an increase modestly, very small, no question about it, from the prior year. The out year funding, again, will be subject to each and every year examining what the annual proposal from the President will be. And as I offered to Mr. Gingrey earlier, I full concede that this does not reflect the ongoing efforts we are engaged in right now with Marion Blakey, the Administrator at the FAA, the Department of Transportation, and the Department of Defense to deal with specifically four major areas: aerospace management, efforts that we have got underway as well as safety and security for aviation considerations that we are trying to sort out, and the quiet aircraft technology approaches. This puts a modest down payment on that first step. I think, if you consider this to be a baseline from which we then make adjustments based on how we coordinate this among——

Mr. LARSON. In my opinion, it is totally inadequate, and when you consider the institutional costs, and when I look at how you broke it down in terms of aeronautics technology and institutional costs, then I don't know how you bridge that gap. And it appears to me that it is going to be much larger than the five percent that we are showing here. And I can only add that I am very disappointed in that, and hope that, you know, the Committee will take a hard look at that. And I know that this is an interest of the Chairman and others on the Committee.

Mr. O'KEEFE. Yes, sir.

SPACE SHUTTLE COLUMBIA: IMAGERY INSPECTION

Chairman BOEHLERT. Mr. O'Keefe, one more question about the e-mails. One of the most significant aspects of the e-mail seems to be the decision not to request the military to do a close inspection of the shuttle. This goes beyond the engineering debates about how to land in the event of a problem with the wheels that you had referred to earlier. Isn't a decision to cancel an inspection the kind of decision that the Administrator might be expected to get involved in? And do you have any sense of how often NASA has requested that the military inspect the shuttle from the ground? And how—finally, how disturbed are you at this point, again, allowing for 20/20 vision, that the inspection request was canceled?

Mr. O'KEEFE. Yes, sir. Well, the over arching aspect of this that I have looked at over the course of the last three and a half weeks is for any imagery that could have been available to us, the determination, I am advised, was based on whether the quality of the imagery that we have received in the past from those sources was sufficiently clear to make a determination of something as small as what could be the consequence in this case. So the determination was on all of the imagery that we had received or had available to

us, offers that were made for certain imagery that in the past did not give us that level of granularity necessary to make that choice was the basis upon which those decisions were made.

Again, how the Gehman Board examines this in their independent judgment as to whether we should have, could have, might have gotten a better degree of understanding of what happened here on orbit had we asked for more imagery, because we received a lot of it. And there was a variety of different things we are now getting an understanding of that we used from lots of different sources, Defense Department as well as FAA and others, that would give us an understanding of exactly what occurred on ascent—on descent as well as the on-orbit requirements that were rendered. But in each case, the determination seems to be, and again, we have got to really look at this carefully, is that the level of imagery would not have been high enough to make a determination that everybody thought was necessary to attain that. Was that a judgment call that was an error? We will find out. And we are going to—you know, definitely, I am sure, that will be an aspect of the Gehman Board's review. And if their findings and recommendations guide us in that direction, that is the direction we are going to be going in.

Chairman BOEHLERT. But once again, with the advantage of hindsight, is that an example, perhaps, of the kind of decision that should be made at the highest level within NASA?

Mr. O'KEEFE. Could be. Could be. I think that is no question that the nature of whether or not these requests should be turned off or turned on might ought to have been at a higher level than that.

Chairman BOEHLERT. But it was—obviously, the decision was made at a level where experienced——

Mr. O'KEEFE. Yes.

Chairman BOEHLERT [continuing]. And very knowledgeable people were making. All right.

Mr. O'KEEFE. Who had received such imagery and data in the past. So again, that—it is a—their familiarity with the All Source information and its utility in these kinds of decisions is partly what you depend on their judgment and ask them as professionals to be responsible for. And they sound like they were. Having said that, again, the larger issue you have raised is one that I think is something we really need to think about is exactly at what point do you make that decision if you think there is an anomaly that would justify that.

Chairman BOEHLERT. At this juncture, I have one final question and then, as usual, we would afford the opportunity for all members to submit questions in writing, and we would hope and anticipate a prompt response, as prompt as possible——

Mr. O'KEEFE. Sure.

CLIMATE CHANGE RESEARCH

Chairman BOEHLERT [continuing]. Under the circumstances, but NASA's Earth sciences programs are among its most useful contributions to research, and NASA contributes more funding than any other agency to climate change research. How does NASA coordinate its Earth science agenda with other Federal agencies?

Mr. O'KEEFE. We are, as you correctly cite, we are the dominant asset provider, if you will, for the Climate Change Research Initiative. We work very, very closely in our Earth Science Enterprise with the—our friends at NOAA, Department of Commerce, who have the lead responsibility for coordinating all Federal assets in this regard. And we work with them very, very closely in using and trying to redirect our capabilities in Earth science toward supporting that particular initiative. And it is a very close-knit relationship that we continue everyday.

Chairman BOEHLERT. What role did you guys—let me rephrase that. What role did NASA play in formulating the draft strategic plan for climate change science?

Mr. O'KEEFE. We were a contributor. The primary lead role was taken again by the Department of Commerce and NOAA. And we were a contributor of responding to their inquiries in that regard. Certainly, the White House and the Counsel on Environmental Quality and others were all part of that determination of what was there, but we were respondent to their request for assets and information and capabilities. And the budget, which you see before you, includes the funding to accelerate.

Chairman BOEHLERT. Yeah. And how do you ensure that the needs of, you know, and instrumentation—as you are developing your instrumentation that it is building for climate change science meets the needs of a broad range of sciences who are funded by a whole variety of Federal agencies? I mean, everybody seems to be in the business these days.

Mr. O'KEEFE. Indeed, in more ways than one. There is—for the Earth Science Enterprise, much like other activities we conduct, there is an advisory group of outside folks, who are primarily universities and think tanks and so forth that are engaged in this, that help us look at the kinds of programs we need to use to respond to these kind of cases. Many of the folks who are participants there are also folks who contribute with other departments or agencies or whatever in dealing with some of the Earth science applications. And as a process of that, again, we are not setting requirements for that Climate Change Research Initiative. We are responding to their requests for how we go about providing not only the information but also the asset use for determining the data and the information they think is relevant. And again, we are guided by an external group of folks who are within the guild, if you will, of the Earth science community of what is the most applicable and most useful capabilities they think will inform that debate in its broadest context.

Chairman BOEHLERT. Thank you. Mr. Hall.

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

NASA WORKFORCE LEGISLATION

Mr. HALL. Mr. Chairman, Ms. Johnson has asked for more time. I just want to briefly say first that I share your interest and the Administrator's interest in considering legislation regarding NASA personnel, work force legislation, and rules. And the gentleman from Jefferson County is dropping a bill in today. I just hope that this year that we consider these changes in this committee giving all of the members on both sides an opportunity to participate in

these important decisions. And I yield my—the remaining of 4 minutes and 45 seconds to Ms. Johnson.

Mr. O'KEEFE. Well, thank you, Congressman Hall. We would welcome your support and very appreciate your willingness to do so. Thank you.

Mr. HALL. Thank you.

Ms. JOHNSON. Thank you very much, Mr. Hall. Mr. O'Keefe, the GAO placed the management of human capitol is one of the greatest challenges facing NASA. With decreases over the past decade from 25,000 in fiscal year 1993 to 18,000 in fiscal year 2002. The problem is likely to get worse since about 15 percent are eligible for retirement now. And in five years, 25 percent will be eligible for retirement, give me some of the activities of which you are participating to remedy this for the future, and how are you including underrepresented groups?

Mr. O'KEEFE. Yes, ma'am, thank you for your——

Ms. JOHNSON. And what—one other thing, what investments are being made at the university levels, most especially historically black colleges to answer that.

Mr. O'KEEFE. Yes, ma'am. Well, again, thank you for your very important question and very thoughtful, I think, analysis of what we share as a major problem. Last June, the President submitted to the Congress legislation specifically related to NASA to help recruit, retain, and work through the best practices of the Federal Government and apply them in NASA for work force management and retention and new inference. That—last June, that legislation having been submitted and the Chairman having called hearings on that question, we are very much looking forward to the Congress enacting those legislative proposals so we can move on with those new tools to do that. As it pertains to diversity objectives and the very important efforts we have with ongoing—in colleges and universities, HPCUs particularly, one of the elements of that legislation that was submitted is a scholarship for service program, which would give us an opportunity for HPCUs, which are engaged in specific research and grant effort that were supporting NASA research, that we have an opportunity first to recruit folks who are graduate assistants and participants in that important research endeavor to hopefully attract them to come to NASA to be part of activity.

So the scholarship for service legislative—within that legislative package, we would love to see your support for that—enactment of that provision so that we can go out and look at how to recruit those folks. Last June, that was—that legislation had been supported. We look for an early enactment of that activity so we can get on implementing that kind of an idea that would give us the opportunity to really make NASA professional and career opportunities available to grad students and undergraduates who are engaged in NASA research activity right now.

Ms. JOHNSON. Thank you very much.

Mr. O'KEEFE. Thank you, Congresswoman.

Ms. JOHNSON. Thank you, Mr. Chairman.

Chairman BOEHLERT. Mr. Gordon.

Mr. GORDON. Well, let me just conclude by thanking you, Mr. O'Keefe for the time you have given us today. As usual, you rep-

resented yourself and NASA very well. And Chairman Boehlert, thanks for a wide-open hearing that you had. I guess—since—I was going to just close out, but since the—it has been brought up, the rules changes—the work force rule changes that you mentioned and that you had been reintroducing those, let me ask you, the last time you did several of those work force rules went beyond NASA. And they were—you were using this authorization to make changes government-wide. Would you expect to do that again, or would you limit your work force rules just to your Agency and the immediate jurisdiction of this committee?

Mr. O'KEEFE. Well, we would be pleased to implement whatever it is that Congress's will of enacting would permit us to do. Right now, we have none of those capabilities, none of those tools. So if you seek to limit them to our applications or someone else's, we would be delighted to do it any way that the Congress sees fit. The approach that has been taken is, I think as Mr. Boehlert has indicated his interest in introducing or developing legislation next week that he would be introducing. On the other side, as I gather it, is having a hearing next week that he has asked me to appear to talk about it. And we are prepared to work with it, negotiate any variation, because right now, we have got nothing.

Mr. GORDON. Mr. Chairman, I haven't seen that yet, but I would hope that you would not take these applications government-wide, and—as we proposed last time, but rather try to keep them within the jurisdiction of this committee.

Chairman BOEHLERT. Thank you. Yeah. It is always—and staff just assures me, reassures me, it is always, from our vantage point, and NASA specifically, in that government-wide. But we will be glad to continue to share the information with all concerned. Is there anyone else?

Well, Mr. Administrator, I want to thank you very much for enduring this, for your good work, and we want to wish you the very best as you continue your very important responsibilities. And please pass on to all of the members of the NASA family our deep appreciation for their hard work and dedication and to finding the answers and looking back so we can prepare for the future. Thank you very much.

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

[Whereupon, at 1:08 p.m., the Committee was adjourned.]

Appendix 1:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Sean O'Keefe, Administrator, National Aeronautics and Space Administration (NASA)

Questions submitted by Chairman Sherwood Boehlert

Q1. Please provide the FY 2003 appropriation in full cost format and the structure of the FY 2004 request:

A1.

	FY 2003 Enacted In approx. Full Cost
TOTAL NASA FY2003 BUDGET	**15,338.9**
Science, Aeronautics & Exploration	**7,404.9**
Space Science	**3,555.1**
Solar System Exploration	1,146.2
Mars Exploration	549.5
Astronomical Search for Origins	793.7
Structure & Evolution of the Univ.	395.7
Sun-Earth Connections	669.9
Earth Science	**1,689.9**
Earth System Science	1,591.4
Earth Science Applications	98.5
Biological & Physical Research	**933.1**
Biological Sciences Research	322.8
Physical Sciences Research	351.2
Commercial Research & Support	255.7
AM + SAGE	3.4
Aeronautics	**1,008.4**
Aeronautics Technology	1,008.4
Education	**218.3**
Education	218.3

Space Flight Capabilities	**7,908.5**
Space Flight	**6,141.9**
Space Station	1,838.6
Space Shuttle	3,835.7
Space Flight Support	467.6
Crosscutting Technologies	**1,766.6**
Space Launch Initiative	1,119.3
Mission & Sci. Measurement Tech.	453.1
Innovative Tech Trans. Partnerships	194.3
Inspector General	**25.4**

Q2. According to GAO, NASA's Inspector General, and NASA's independent auditor PricewaterhouseCoopers (PWC), the Agency lacks adequate controls to ensure that Property, Plant and Equipment (PPE) and Materials accounts are presented accurately in the financial statements.

Q2a. What actions are you taking to address these problems, and how long will it take to correct them?

A2a. NASA is taking several actions to enhance the internal controls over PP&E and Materials for the FY 2003 financial reporting and audit cycle. Actions include improving contractor-held property reporting by establishing quarterly reporting requirements for detail property data, including work-in-process and materials, establishing contractor working groups, strengthening documentation requirements, and increasing guidance to contractors. Further, NASA will increase reviews and validations of contractors' data, provide additional training to NASA property accountants, and hold training seminars for contractors. All actions are expected to be completed in FY 2003 and result in improved reporting for the FY 2003 Performance and Accountability Report.

Q2b. Will the changes be implemented in time for the fiscal year 2003 audit?

A2b. Yes, NASA and its auditors have spent considerable time reviewing NASA planned corrective actions during FY 2003 in response to the audit recommendations. NASA expects to complete these planned corrective actions during FY 2003 and result in the removal of the material weakness associated with PP&E and Materials.

Q2c. Will the Integrated Financial Management Plan (IFMP) core financial model, if used properly, address the weaknesses related to NASA's internal controls over, 1) materials and property, plant and equipment, particularly that held by contractors and, 2) processes for preparing financial statements and the Performance and Accountability Report? If not, which specific problems cannot be addressed by the core financial module, and will other modules address these problems?

A2c. NASA's problems with the contractor held property were not a direct result of NASA's accounting system, but rather with the frequency and quality of the data received from contractors. As discussed above, NASA's planned corrective actions will require quarterly reporting (compared to the previous year-end reporting only) and include quality control reviews of the data submissions. NASA does expect the implementation of IFMP, along with other planned corrective actions, including additional NASA staff, training and quality control processes to result in the removal of the material weakness rendered on the process for preparing the Performance and Accountability Report.

Q3. The National Space Transportation Policy issued by the White House on August 5, 1994, states that U.S. government payloads will be launched on space launch vehicles manufactured in the United States, unless exempted by the President. It goes on to state this policy does not apply to the use of foreign launch vehicles on a no-exchange-of-funds basis, subject to certain limitations, and that such use will be subject to interagency coordination procedures.

Q3a. What projects is NASA planning or performing that require an exemption to the restriction on use of foreign launch vehicles?

A3a. NASA utilizes domestic launch services as the prime mode of space access for all NASA primary payloads requiring a NASA-provided launch. NASA has no primary missions base-lined that require NASA to acquire a foreign launch service. NASA has only one secondary payload under consideration that may require an exemption request (see answer 3b).

Q3b. Please provide a list of the projects and the status of any requests for exemption.

A3b. NASA has been evaluating the potential need for an exemption to the policy for the Space Technology 5 (ST–5) mission. The mission was designed for launch as a secondary payload aboard a U.S. Expendable Launch Vehicle (ELV), but is also compatible with flight on an Ariane V secondary adapter. NASA notified the Office of Science and Technology Policy (OSTP) that it was having difficulty in the identification of a domestic secondary opportunity and initiated an exemption request for the ST–5 payload. NASA issued an RFP to domestic sources for the ST–5 mission and is currently evaluating a possible opportunity for ST–5 to fly on a domestic vehicle as a secondary payload.

Q3c. Please explain the interagency coordination process for seeking approval for this type of exemption.

A3c. The process: NASA provides OSTP a request for exemption with appropriate justification. OSTP then coordinates with the affected agencies and provides its decision.

Q4. Section 126 of the National Aeronautics and Space Administration Act of 2000 (P.L. 106–391), requires the Administrator to give public notice anytime NASA conducts a space mission in which a foreign entity will participate as a supplier of the spacecraft, spacecraft system, or the launch system. Notice must be given at least 45 days prior to entering into an obligation. Please provide the date when public notice will be given pursuant to P.L. 106–391 section 126 for each project listed in question 3 above.

A4. As noted in the response to number 3 above, NASA is currently evaluating a domestic launch opportunity for the ST–5 mission as a secondary payload. Should NASA be unsuccessful in negotiating this domestic launch opportunity, public notice would be provided when the solicitation for a secondary launch service from a foreign supplier is released. This notification would be at least 45 days prior to any contractual award.

Q5. According to NASA's Integrated Space Transportation Plan, NASA will make a decision about whether to extend the Space Shuttle program in the 2010 timeframe.

[Please note that the following answers are based on current policy. The report of the *Columbia* Accident Investigation Board may lead NASA to make changes to the Integrated Space Transportation Plan, including the Shuttle Life Extension Program.]

Q5a. When assessing candidate projects for inclusion into the Shuttle Service Life Extension Program (SLEP), what planning horizon is NASA using as the expected service life of the Shuttle?

A5a. We are currently using 2020 as the planning horizon for incorporating potential projects in the SLEP.

Q5b. If the Orbital Space Plane (OSP) is developed to provide for crew transport by 2012, when will the shuttle system be retired?

A5b. No decision has been made regarding the retirement of the Space Shuttle. We currently plan to use the Shuttle through at least the middle of the next decade.

Q5c. When the Gehman Board makes its final recommendation, will the SLEP budget be used to fund the required Shuttle modifications?

A5c. The President's budget for FY 2004 reflects our current budget estimates for NASA's Shuttle investments. However, we do not yet know the magnitude of the Shuttle modifications that will be required to respond to the Gehman Board and thus have not determined exactly how the modifications will be funded. Gehman Board recommendations that focus on Shuttle system modifications needed in the long-term (rather than on return-to-flight issues) may well be incorporated into the SLEP program.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Sean O'Keefe, Administrator, National Aeronautics and Space Administration (NASA)

Questions submitted by Chairman Dana Rohrabacher

Q1. NASA's fiscal year 2004 budget request for Project Prometheus is $279 million with an estimated $3 billion over the next five years.

[NASA Clarification: The budget for Project Prometheus includes funding for radioisotope power system advanced technology development; for research on reactor, power conversion, and advanced propulsion systems; and to initiate planning for the Jupiter Icy Moons Orbiter (JIMO) mission and begin the technology development that will lead to a flight decision.]

Q1a. If the Jupiter Icy Moons Orbiter (JIMO) flies in 2013, what is the estimated total cost of the program (using full cost accounting)?

A1a. We are managing the Project Prometheus program, including JIMO, within full cost accounting requirements, and the FY 2004 budget submission reflects full cost for FY 2004 through FY 2008. Given that we are in the early planning phase for JIMO, we are just now developing program life cycle cost estimates, which will be validated by independent cost estimates prior to confirmation.

Q1b. Please provide a breakdown of the cost for Project Prometheus including design, development, and operations. Provide a separate breakdown for the funding required for nuclear power and propulsion research and development, and the JIMO orbiter.

A1b. Project Prometheus is a nuclear systems program with three primary components: a radioisotope power system development program, an advanced technology research and development program for fission-based nuclear electric power and propulsion, and a proposed flight mission, JIMO. The total Project Prometheus program budget through FY 2008:

Total Project Prometheus Budget
($ Millions FY 2003-FY 2008):

FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	TOTAL
98.9	279.2	547.1	712.1	742.7	771.3	3,151.3

Note: The FY 2003 number is not in full cost; the FY 2004-FY 2008 numbers are in full cost.

*Source: FY04 Budget Submittal

The nuclear power, or Radioisotope Power Systems (RPS) development program, focuses on developing advanced radioisotope power systems to significantly enhance the capability of future space science missions. The Prometheus budget includes funding for the design and development of a Stirling Radioisotope Generator, a new technology that is predicted to achieve major increases in efficiency over older model radioisotope thermoelectric generators, and is a candidate for flight on the 2009 Mars Science Laboratory mission. The budget also funds technology research into even more advanced technologies, almost all of which are being selected competitively. There is no funding for operations in this budget element. The budget is as follows:

Radioisotope Power Systems Budget
($ Millions FY 2003-FY 2008):

FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
42.7	55.7	70.9	56.4	60.3	59.3

Note: The FY 2003 number is not in full cost; the FY 2004-FY 2008 numbers are in full cost.

*Source: FY04 Budget Submittal

Please note that the design and development of the Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) is funded within the Mars program as a primary technology candidate for flight on the 2009 mission. The MMRTG activity is managed in close coordination with the Project Prometheus RPS technology work.

The nuclear propulsion program will conduct advanced technology research to support development of fission-based reactors, power conversion systems and advanced propulsion systems. Part of this technology research development work will support both JIMO and relatively near-term, follow-on missions; other parts will support even longer-term technology development, aimed at much more efficient and powerful nuclear-fission-powered missions for future decades. There is no funding for operations in this budget element. The budget for the nuclear propulsion program element is as follows:

Nuclear Propulsion Research Budget
($ Millions, FY 2003-FY 2008):

FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
16.3	130.9	168.2	164.6	107.9	108.1

Note: The FY 2003 number is not in full cost; the FY 2004-FY 2008 numbers are in full cost.

*Source: FY04 Budget Submittal

Project Prometheus also has a proposed mission, the Jupiter Icy Moons Orbiter mission, which is currently in initial design phase. The cost estimates are being developed as part of Phase A, which includes funded industry estimates. The current budget profile is as follows:

Jupiter Icy Moons Orbiter
($ Millions, FY 2003-FY 2008):

FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	
39.9	92.6	308.1	491.1	574.5	603.9

*Source: FY04 Budget Submittal

Q1c. What is the proposed radioactive material and estimated quantity to be used in the power system of the Prometheus spacecraft?

A1c. For the radioisotope program, the fuel requirements will be based on the mission and spacecraft design. Radioisotope Power Systems (RPS) use plutonium 238 in a ceramic form. The heat generated by an RPS is converted to electricity for spacecraft use. The amount of fuel, and indeed the choice of power supply, would be dependent on the requirements of the mission and the design of the spacecraft. As of this writing, there are no missions currently at a stage of development where we could state exact fuel requirements for the RPS under current development.

The fission reactors that will be developed by Project Prometheus would use uranium 235. Since we have not designed the reactor and spacecraft yet, we are not in a position to state exactly how much fuel we will need. Calculations of fuel mass are based on the amount of energy required and the level of fuel enrichment. The reactor system will provide power to the spacecraft, including the propulsion system.

Q1d. What is the proposed radioactive material and estimated quantity to be used in the propulsion system of the Prometheus spacecraft?

A1d. For both types of system, radioisotope and fission reactor, the radioactive fuel is used to create heat that, in turn, is converted into electricity that can be used to provide power to the electric propulsion system and any other spacecraft electrical needs. The amount of fuel would be dependent on mission requirements and spacecraft design. Various options are being considered, but the exact fuel has not yet been determined.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Sean O'Keefe, Administrator, National Aeronautics and Space Administration (NASA)

Questions submitted by Representative Gil Gutknecht

Q1. What significant science objectives have been realized as a result of research performed aboard the International Space Station? What are the specific findings that could not have been gained by ground-based research?

A1. The past year included a major increase in research productivity on the International Space Station, as construction and outfitting advanced towards completion of Node 2 (also known as "U.S. core complete"). NASA has now performed 72 new experiments on the ISS through Increment 6. Many of these investigations span more than one increment. Astronauts conducted the first materials science research on the ISS, tested medical procedures for controlling the negative effects of space flight, deepened our understanding of changes to bone and the central nervous system that occur in space, studied plant growth in microgravity, conducted advanced cell culturing research, and broke new ground in the study of dynamic systems made up of tiny particles mixed in a liquid (colloids).

a. The Physics of Colloids In Space (PCS) experiment returned information about the development and dynamics of colloid materials. Colloids are mixtures of very small particles suspended in a liquid—paint and toothpaste are both usually made of colloids. Physicists studying colloids in space are exploring the processes by which particles in colloids arrange themselves into regular patterns (crystal lattices). PCS researchers report that they have been able to observe significant phenomena that have never been observed on Earth, only in a microgravity environment. These data are important to the future production of materials for storing, transferring and processing of information using optical switches, filters, and lasers for advanced telecommunication networks and displays. Other potential uses include improvements in the shelf life of foods, cosmetics and paints, common products made of colloid-based materials.

b. NASA and Baltimore-based biotechnology research company StelSys, LLC, teamed up to test the function of human liver cells in the microgravity environment aboard the International Space Station, comparing the results to the typical function of duplicate cells on Earth. Growing cells outside the body is an important element of biomedical research on Earth; cells grown on Earth tend to settle to the bottom of their container and generally do not form the same three-dimensional tissues that they would form in the body. ISS cell culturing equipment allows researchers to observe cell cultures that can develop without settling out of solution. The findings of the StelSys experiment will provide unprecedented information about the effects of microgravity on the proper function of human liver cells, offering new insight into maintaining the health of humans living and working in space. The StelSys liver cell (hepatocyte) study was performed in the ISS by the Expedition 5 crew. Cells grown on board in a cell culturing apparatus onboard the ISS were frozen and returned to researchers on Earth. Researchers at StelSys are now analyzing microanatomical, biochemical, and molecular genetic properties of the samples compared with ground controls.

c. The "Photosynthesis Experiment and System Testing Operation" experiment conducted on Increment 4, provided the first replicated data obtained from plants, grown under good environmentally controlled conditions, to demonstrate that existing models using plants for advanced life support applications can be used without significant modification. While this has been the operating hypothesis for many years, the space station has provided the first opportunity to directly test this hypothesis in a scientifically credible manner. The objectives of the experiment were to determine the effects of microgravity on photosynthesis and carbohydrate metabolism of wheat. Initial assessment of the data indicates that there was no difference in growth rate or dry mass of wheat grown on the ISS. In addition, there was no difference in daily photosynthesis rates, leaf responses to canopy CO_2 concentration, or light intensity. Six on-orbit plantings, and 7 on-orbit harvests of wheat were conducted during Increment IV. Over 280 individual plants were harvested and frozen for analysis upon return to Earth, 18 plants collected for microscopic analysis, four plants for genetic analysis, and over one gigabyte of data was collected. The experiment was fully replicated in a 14-day ground control. Over 3000 video images of developing plants were obtained through the flight hardware.

The above are but three examples of the value of space-based research in zero gravity conditions. However, it is well known that for every space experiment, dozens to hundreds of preliminary experiments, ground controls and related studies must be conducted in laboratories on Earth. For the various OBPR research disciplines, accounting for the phase of the research in these disciplines, a range of 5–10 ground projects for each flight project is generally appropriate. For example, currently, radiation research is primarily a ground-based OBPR program.

It is NASA's policy that what can be done on Earth, can and will be done on Earth. If the research can be done by other agencies or the private sector, it is done there. When a researcher proposes a flight experiment, peers review it, and the same two questions are asked: Does it need microgravity? Will it add significantly to the scientific field of knowledge? Only when the answer is "yes" to both questions does an experiment fly in space.

The work that is done on the ground is in service to flight research—you do not get one without the other. From the ground program, our sponsored researcher Wolfgang Ketterle at MIT won the Nobel Prize in physics in 2001 for atom lasers—he specifically thanked NASA's program—our human spaceflight program—for our sponsorship. Similarly, five other Nobel Prize winners wrote to the President's Science Advisor noting the benefits of spaceflight for their field of fundamental physics.

Q2. How much money has NASA received in fiscal 2001 and 2002 from commercial licensing agreements for NASA developed research and technology?

A2. The following royalties and fees were received by NASA (excluding JPL/California Institute of Technology) from commercial patent and copyright licenses:

FY 2001: $1,007,740

FY 2002: $1,081,170

ANSWERS TO POST-HEARING QUESTIONS

Responses by Sean O'Keefe, Administrator, National Aeronautics and Space Administration (NASA)

Questions submitted by Representative Rob Bishop

Q1. What are the technical risks and milestones to successfully develop the Orbital Space Plane (OSP) crew transfer capability by 2012? What are the barriers to accomplishing crew transfer capability by 2012, and what is the plan for managing and reducing the risk?

A1. Some of the top risks involved in successfully executing the OSP Program include:

- The design and integration of the Orbital Space Plane flight vehicle(s) onto an Expendable Launch Vehicle including the associated human rating of the system and ground launch processing needs.
- The ability to define the OSPP (Orbital Space Plane Program) Level 2 requirements in support of the Systems Requirements Review at the appropriate level to properly reflect the OSPP objectives without excessively driving the design solution.
- The ability to meet the OSPP Level 1 Requirements within the cost and schedule constraints.
- The ability to perform the required technology demonstrations in a timely manner to support the OSPP design.

Key near-term milestones include:

- The System Requirements Review, scheduled to be complete in December 2003.
- The System Design Review, scheduled to be complete in June 2004 followed by the Full Scale Development Decision in September 2004.
- The Preliminary Design Review, scheduled to be complete in FY 2005.
- The Critical Design Review, scheduled to be complete in FY 2007.

The OSP Program is implementing a risk management process to identify and track the top program risks and ensures the risks are adequately mitigated. This will include using Probabilistic Risk Assessment as a tool for managing the risks. External review teams and independent review teams are being used to ensure the program remains on track. An independent cost validation will be performed utilizing a Cost Analysis Requirements Document prior to the Full Scale Development decision. In addition, we are ensuring fiscal accountability by using a proven Earned Value Management system to track actual cost and schedule performance as compared to plans.

Q2. The OSP Level I requirements make specific comparisons to other systems, including the Space Shuttle and Russian Soyuz. The OSP requirements specify that the risk of crew loss shall be lower than the Soyuz vehicle for crew return, and lower than the Space Shuttle for crew transport. The Program Interpretation Document (PID) specifies the minimum Probabilistic Risk Analysis (PRA) targets. Please provide an explanation summary of how the PRA targets stated in item 4b and 6 of the PID were derived.

A2. PRA targets are defined for the Crew Rescue Vehicle (CRV) and the Crew Transfer Vehicle (CTV). The PRA target for the CRV is that the minimum threshold probability for the loss of crew be below 1/800 with a 50 percent confidence with an objective probability of being below 1/800 with an 80 percent confidence. The PRA target for the CTV is that the minimum threshold probability for the loss of crew be below 1/400 with 50 percent confidence with an objective probability of being below 1/400 with an 80 percent confidence. The PRA target for the CTV is twice that for the CRV since there are two involved crew transfers for the CTV and one for the CRV.

These targets were selected based on three considerations—1) they represent significant reductions in risk exposure over the Space Shuttle and the Soyuz, 2) they are believed to be achievable with high quality design and operation, and 3) they are able to be meaningfully demonstrated using current PRA technology. Lower target values would be artificial in that unrealistic assumptions would be needed to demonstrate their compliance. The PRA target values that were selected accommodate contributions from human errors, dependent failures (termed common cause

failures), and phenomenological events such as fires and explosions. When these contributions are ignored, then lower risk values can be calculated, but these lower calculated values are unrealistic because of their omissions. The PRA targets thus represent significant risk reductions that are meaningful, achievable, and demonstrable.

Q3. The Level I requirements compare the time to execute an OSP mission with the time to execute a Space Shuttle mission. What is used as the baseline time to plan, process the vehicle, and execute a Space Shuttle flight?

A3. Level I requirement #9. Compared to the Space Shuttle, the system shall require less time to prepare and execute a mission and have increased launch probability.

A baseline time to execute a Space Shuttle mission was not defined in the Level 1 requirement formulation. Quantitative requirements for launch probability will be defined in lower level requirements documents. We will use the formulation period to specifically define the requirement in support of the Systems Requirements Review this fall. As a reference, planning a Shuttle mission can take several years, and the shortest time to process the vehicle between missions is 3–4 months.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Sean O'Keefe, Administrator, National Aeronautics and Space Administration (NASA)

Questions submitted by Representative Jo Bonner

Q1. Please provide a description of the research that NASA has performed, in conjunction with the National Oceanic and Atmospheric Administration (NOAA), on the effects of "Red Tide" including goals, objectives, and funding expended as well as anticipated to perform this research.

A1. NASA's contributions are in two types. Several of the Earth Observing Satellites NASA has launched over the past five years are used by researchers in other government agencies and in academia to study the biology in the coastal oceans. In addition, NASA funds some peer reviewed scientific investigations in the context of its broader research strategy.

NASA's Earth Science Enterprise's (ESE) research on "Red Tides" and other forms of Harmful Algal Blooms (HAB) is coordinated through the multi-agency program ECology and Oceanography of Harmful Algal Blooms (ECOHAB). Other members of ECOHAB include the National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA), and the Office of Naval Research (ONR).

The agencies formed ECOHAB in 1997 to collaborate on the collective goals for the detection, understanding, monitoring, modeling, and management of HABs. ECOHAB sponsors an interagency solicitation of research proposals each year. Each agency has their respective research goals for participation in ECOHAB, and each funds proposal that align with their respective goals and missions.

NASA's research goals and activities in ECOHAB include: development of remote sensing techniques for detection and tracking of HABs in near-shore coastal environments, differentiation of HABs from suspended sediments and organic compounds in optical sensors, quantification of pigment concentration and understanding of optical properties associated with HABs in near-shore waters.

NOAA conducts research through ECOHAB on the relationship of HABs to the surrounding environment in order to apply effective techniques for prevention, control, and mitigation to communicate and reduce the impacts of HABs. Through ECOHAB, NASA and NOAA coordinate research on development and use of remote sensing data and techniques and characterization of HABs for detection and tracking.

NOAA and EPA are the primary Federal Government agencies funding HAB research, and these agencies have specific HAB-related programs. NASA's ESE funds HAB activities through existing Earth science programs, rather than through a separate program dedicated to HABs.

ESE funded a project entitled "Eco-physiology of sub-populations of *Alexandrium tamarense*," for $512 thousand (covering FY 1998–FY 2002), through the ECOHAB solicitation. The objective of this project was to examine the factors that cause the *Alexandrium tamarense* alga to bloom.

Prior to FY 2003, the proposals submitted to the ECOHAB solicitation that aligned with NASA's objectives were judged "low" by the ECOHAB peer review process. However, three proposals submitted to the ECOHAB FY 2003 solicitation align with NASA's objectives.

1. NASA has selected two proposals for funding: "Satellite Analysis of the Physical Forcing of Algal Blooms in the Pacific Northwest Coastal Ocean" (approximately $387 thousand over three years) by the Applied Physics Laboratory, University of Washington—seeks to integrate and analyze satellite data sets to identify and monitor physical conditions that favor HABs in Pacific Northwest coastal waters.
2. "Role of mycosporine amino acids in UV photoecology of harmful dinoflagellates" (approximately $388 thousand over three years) by Scripps Institute of Oceanography, University of California San Diego—seeks to improve early detection of harmful algal bloom formation and predict growth of species of concern.
3. In addition, NASA and ONR have selected the following three-year proposal for funding: "Optical Detection and Assessment of the Harmful Alga, *Karenia brevis*" (approximately $595 thousand) by the University of Southern Mississippi—to refine and evaluate optical approaches to detect and monitor bloom events of the red tide alga, *Karenia brevis.*

Q2. Please describe the roles and responsibilities of NASA and NOAA in this research.

A2. As described above, NASA and NOAA are partners in the ECOHAB program, and all the ECOHAB partners coordinate activities.

In addition to the research described above, NASA and NOAA coordinate and share satellite remote sensing data for the detection and tracking of Harmful Algal Blooms. Currently, NOAA operates the HAB Bulletin and the HAB Mapping System to provide forecasts and information to the public on algal blooms in the Gulf of Mexico. To support the HAB Bulletin and Mapping System, NOAA uses data from SeaWiFS and QuikSCAT satellites related to ocean color (detection of algae) and ocean surface winds (transport of algae). NASA and NOAA are examining the use of other NASA research and satellite data, such as MODIS, for further augmentation of the HAB Bulletin and Mapping System.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Sean O'Keefe, Administrator, National Aeronautics and Space Administration (NASA)

Questions submitted by Representative Ralph M. Hall

Q1. Please list the studies that NASA has conducted or asked a contractor to conduct within the last five years of potential Space Shuttle crew survivability systems for use in case of an accident. Please provide the specific objectives, cost, and the specific conclusions of each study.

A1. Crew survivability has been studied continuously since the *Challenger* accident; however, in 1999 the Space Shuttle Program was provided $5 million for additional studies on crew escape/survivability. The Orbiter Project, together with United Space Alliance and Boeing Company, studied 11 different concepts including ejection and extraction options. The guidelines for the concepts included: using a seven-person crew as the model; incorporating the changes into the fleet by 2005; and considering only the ascent phase of the mission in the studies. The estimated costs of the proposals ranged from $1.2–5 billion and required four to six years of development after authority to proceed before an option could be incorporated into the fleet. Several of the options were technically viable, however, none could meet the requirement for a seven-person crew or be incorporated by 2005. It is doubtful whether any of the options would have offered a successful recovery of the *Columbia* crew.

Q2. At the February 12, 2003 joint hearing on the Columbia *accident, you indicated that NASA would take another look at potential Space Shuttle crew survivability systems. What are your specific plans for that review? Please note that I am not asking about your plans for the Orbital Space Plane or your plans for Space Shuttle safety upgrades. I am asking about potential crew survivability systems for use in the event of another Space Shuttle accident.*

A2. The evaluations of crew escape systems technology continues. At the March 2003, Space Shuttle Service Life Extension Program (SLEP) summit, the Space Flight Leadership Council directed that Crew Survivability be added as project. It should be noted, however, that no crew escape system has been demonstrated as viable above 85,000 feet or above Mach 3. *Columbia* was traveling at a much higher altitude and speed when the accident occurred.

Q2a. When do you plan to begin the study of potential Space Shuttle crew survivability systems?

A2a. The crew survivability study is currently underway.

Q2b. What will be the specific objectives of the study?

A2b. The current activity is focused on better defining the benefits, cost, schedule and potential impacts of adding ejection seats to the flight deck of the Orbiter. We are also collecting and summarizing previous survivability studies for review by senior management.

Q2c. What do you anticipate will be the cost of the study?

A2c. The team estimates that the study will cost approximately $1 million.

Q2d. When will the study be completed?

A2d. Results of the study will be presented to senior management at the 2004 SLEP summit, which is tentatively scheduled for February.

Q2e. Will the study be conducted by NASA employees or by contractors, or by both?

A2e. The study team includes both NASA and industry representatives.

Q3. Prior to the Columbia *accident, NASA's revised Integrated Space Transportation Plan indicated that the Space Shuttle would continue operations in support of the Space Station at least until 2015. Is that still your assumption or has the date changed as a result of the likely delay in completing the Space Station due to the accident?*

A3. The current NASA Integrated Space Transportation Plan (ISTP), formulated in late 2002, assumes that the Space Shuttle will operate through at least the middle of the next decade or until a replacement is available. Through the Shuttle Service Life Extension Program (SLEP), NASA is planning its investments in the Space Shuttle system to ensure that it is able to sustain safe operations through 2020.

NASA will continue to assess the requirements of ISS operations and the ability of alternative transportation systems, such as the Orbital Space Plane, to meet those requirements. Based on this assessment, NASA will decide to extend Space Shuttle operations further or to retire the Shuttle.

In light of the *Columbia* accident, NASA is reassessing the ISTP. NASA is awaiting the final findings and recommendations of the *Columbia* Accident Investigation Board with respect to the Space Shuttle program. Until NASA can determine the implications for the Board's immediate and long-term recommendations for the Space Shuttle, and our implementation strategy for responding to them, it would be premature to draw conclusions about specific changes to the Agency's Integrated Space Transportation Plan. Current planning suggests that NASA will be able to complete the U.S. core assembly of the International Space Station (ISS) within one to two years of Shuttle return to flight. As the CAIB concludes its work, we will keep the Committee informed of NASA's implementation of the CAIB recommendations and adjustments to the ISTP.

Q4. Is there any requirement for the Orbital Space Plane to do any other missions besides taking crew and limited cargo to and from the International Space Station? If so, what in specific terms are those missions?

A4. No. The Orbital Space Plane Program Mission Needs Statement is "The vehicle(s) and associated systems will support U.S. ISS requirements for crew rescue, crew transport, and cargo." There is no language in the Level 1 Requirements for any missions other than those mentioned above.

Q5. Regarding the future of the Space Shuttle program:

Q5a. Under your Integrated Space Transportation Plan, how many more Shuttle flights are anticipated before they are replaced by a new transportation system?

A5a. The Integrated Space Transportation Plan (ISTP) calls for sustaining the Space Shuttle through at least the middle of the next decade, aggressively pursuing a crew transfer vehicle (the Orbital Space Plane) and developing the technologies that will enable future launch systems. In order to provide flexibility, the ISTP does not specify exactly when the Shuttle will be phased out. Under the ISTP, Shuttle lifetime could be extended to 2020 or beyond, or the Shuttle's phase-out could begin when the Orbital Space Plane becomes operational in the 2012 time frame. The date of the Shuttle's return to flight is also uncertain. For these reasons, it is impossible to say how many more Shuttle flights are anticipated before the Shuttles are replaced by a new transportation system.

Q5b. What is your current estimate, in light of the Columbia *accident, of the risk of losing another Shuttle during the course of those remaining missions?*

A5b. NASA is reevaluating its estimates of the probability of losing a Shuttle after the *Columbia* accident. The new probability numbers should be available in October 2003.

Q5c. From your answers to (a) and (b), one may calculate the chance of another Shuttle loss before the system is retired. Is that an acceptable level of risk to assume? If not, what would be an acceptable level of risk, and how much should be willing to spend to achieve the acceptable risk level?

A5c. NASA will address the questions of acceptable level of risk and additional cost as part of the return to flight process. However, until we have seen the totality of the *Columbia* Accident Investigation Board recommendations, and determined what process changes or potential redesigns are required, we will not be able to adequately address these questions.

Q6. On several occasions, the Associate Administrator for Space Science has been quoted as saying that the cost of Project Prometheus, including the Jupiter Icy Moons Orbiter, would cost on the order of $8 billion to $9 billion through 2012. The FY 2004 budget requests states that Project Prometheus will cost $3 billion through 2008.

- *What will the additional $5–6 billion for the years FY 2009 to FY 2012 be used for?*
- *What is the estimated cost profile for Project Prometheus over that period?*
- *Please provide as detailed a breakdown as possible of the $8–9 billion into cost categories and the levels of funding for each category.*

A6. The quote was not intended to provide a confirmed budget estimate, but rather was an extrapolation, based on mid-decade funding levels, of what the total program

costs might be when Project Prometheus, and its required technology research and development elements, reaches maturity. At that time, significant efforts will be underway on follow-on missions using these systems.

With regard to the budget for the proposed Jupiter Icy Moons Orbiter mission, which is part of Project Prometheus, NASA has just begun preliminary spacecraft design, mission planning, and cost estimation efforts. When we complete the initial mission studies (in early FY 2005), we expect to be able to provide accurate and complete project life cycle cost estimates. NASA will also submit an independent life cycle cost estimate to Congress.

Q7. What does NASA assume the operational lifetime of the International Space Station (ISS) to be?

A7. The current operational lifetime for the ISS was projected out to 2016 for budget planning and ISS structural certification purposes. ISS operations could continue well past 2020 based upon instrumentation and data collection capabilities in place to support ISS structural life extension, in conjunction with implementation of an ISS service life extension program. The ISS Program will continue to assess the requirements in this area to ensure that structural life and functionality can be extended, if supported by NASA strategic requirements.

Q7a. What are the annual upmass requirements over that assumed lifetime, and what is the composition of that upmass?

A7a. Projected upmass requirements and the composition of the upmass are provided in Attachment A–1 and Attachment A–2. Over the lifetime of the ISS, annual upmass requirements fluctuate based on assumptions about crew, vehicle, and science requirements. Current projections are based on a crew of three. ISS traffic models assume five Space Shuttle missions beginning in 2006, and four Progress and two Soyuz vehicles per year. Beginning in 2004, the International Partners expect to launch one Automated Transfer Vehicle (ATV) each year, and beginning in 2007, one H–II Transfer Vehicle (HTV) per year. These traffic models may change in response to the recommendations of the *Columbia* Accident Investigation Board.

Additional crew supply upmass will be required if we are able to take advantage of an enhanced configuration and increase the size of the crew beyond three. In an enhanced configuration, the ISS would require two additional Soyuz launches per year beginning in 2007 until an Orbital Space Plane Crew Return Vehicle/Crew Transfer Vehicle is available. The upmass requirements identified through 2008 are considered to be high confidence numbers. The upmass requirements numbers post 2008 are best estimates.

Q7b. What are the annual downmass requirements over that assumed lifetime, and what is the composition of that downmass?

A7b. The annual downmass requirements over the assumed lifetime of the ISS are based on requirements for flight hardware return and repair, science research products and payload racks, and some crew support returnable items.

Specific downmass or "U.S. Operating Segment (USOS) recoverable cargo" requirements and the composition of that downmass under the above requirements are provided in Attachment B.

Q7c. What are the annual numbers of crew member transfers to and from ISS over that assumed lifetime, and what is the assumed stay-time on ISS for each crew member visit?

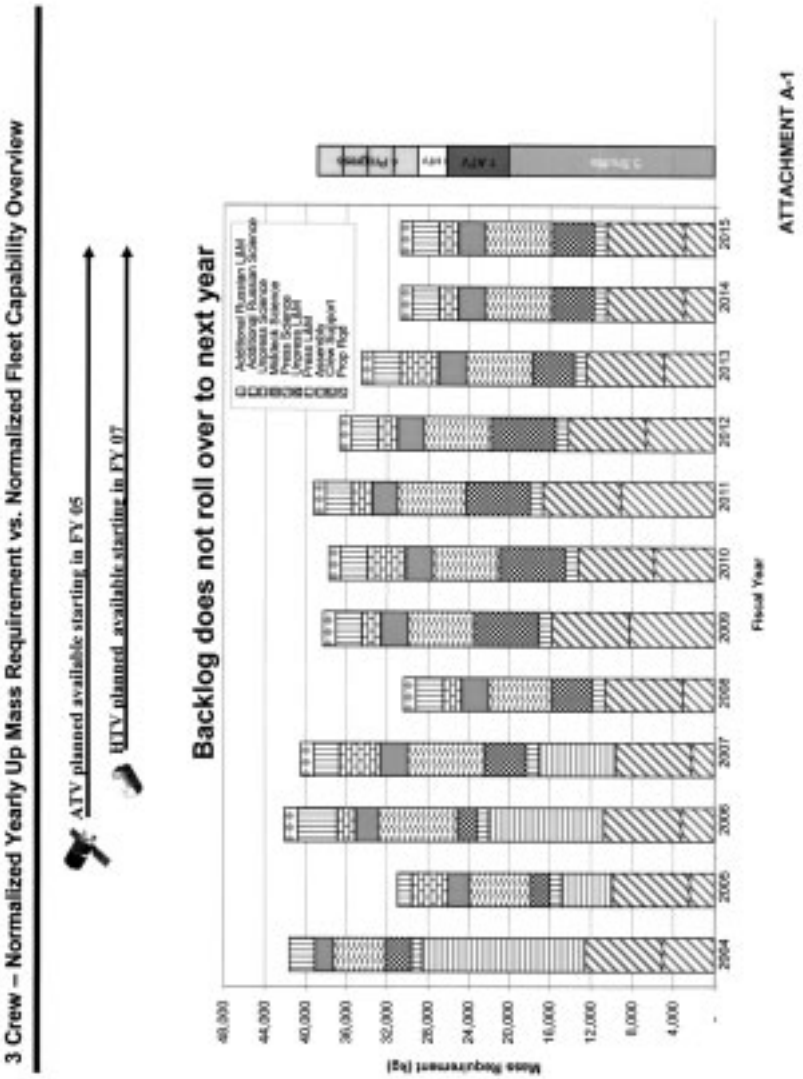
A7c. Currently, ISS crews are rotated every four to six months (two to three times per year). Factors influencing planned expedition durations include training, increment objectives, crew baseline data collection, and Shuttle flight schedules.

Q8. Is it true that NASA is planning to terminate 10 of the 17 Commercial Space Centers over the next year without Congressional consultation or review? If so, what is the reason for the planned terminations? Which Centers are to be terminated?

A8. As a part of the FY 2004 budget request, the Space Product Development and Research Partnership Centers programs (formerly known as the Commercial Space Centers) are being significantly refocused to directly contribute to the agency vision and mission. The current 15 Research Partnership Centers are engaged in areas such as biotechnology, biomedicine, advanced materials processing, agribusiness, and spacecraft technology and communication development. NASA remains committed to ensuring diversity of research on the International Space Station, including market-driven, commercial research. However, the Research Partnership Centers, which generally need a higher degree of certainty and shorter research time

frames than academia, have been hard hit by lack of access to space; therefore, we are phasing down this effort and focusing the program consistent with efficient on-orbit utilization. The directors of the Research Partnership Centers are supportive of this approach.

NASA will continue to facilitate the commercialization of space, and will ensure that commercial researchers have efficient access to space. The proposed reduction will be undertaken through a comprehensive and objective assessment of the present commercial research program, including feedback from an ongoing independent review of the Research Partnership Centers program to be completed in FY 2004. The Research Partnership Centers Center Directors are fully engaged and will actively participate in the program restructure. A recommendation regarding the refocused program will be submitted with the FY 2005 budget proposal.


3 Crew – Normalized Yearly Up Mass Requirement vs. Normalized Fleet Capability Overview
ATV planned available starting in FY 05
HTV planned available starting in FY 07
Backlog does not roll over to next year
Additional Russian LAM
Additional Russian Science
Logistics
Mission Science
Progress Cargo
Progress LAM
Soyuz LAM
Other Support
Prop Roll
Mass Requirement (kg)
Fiscal Year
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
ATTACHMENT A-1

Upmass Data (Does not include assembly H/W)

3 Crew

New Data	Kg Prop Rqd	Kg Crew Support	Kg Press L&M	Kg Unpress L&M	Kg ** Press Science	Kg ** Mideck	Kg ** Unpress Science	Additional Russian Science	Additional Russian L&M
FY04	5,008	7,540	977	2,618	5,052	1,822	-	2,603	-
FY05	2,384	7,540	1,117	1,828	6,088	2,094	3,547	1,388	
FY06	3,261	7,540	1,258	1,934	7,792	2,094	1,837	3,953	1,200
FY07	2,134	7,540	1,258	4,032	7,638	2,638	4,107	2,515	1,200
FY08	3,084	7,540	1,258	4,032	6,077	2,611	1,900	2,615	1,200
FY09	8,226	7,540	1,258	6,312	6,605	2,584	1,900	2,615	1,200
FY10	5,806	7,540	1,258	6,312	6,605	2,584	3,800	2,615	1,200
FY11	9,191	7,540	1,258	6,312	6,605	2,584	1,900	2,615	1,200
FY12	6,662	7,540	1,258	6,312	6,605	2,584	1,900	2,615	1,200
FY13	4,890	7,540	1,258	4,032	6,605	2,584	3,800	2,615	1,200
FY14	3,000	7,540	1,258	4,032	6,605	2,584	1,900	2,615	1,200
FY15	3,000	7,540	1,258	4,032	6,605	2,584	1,900	2,615	1,200

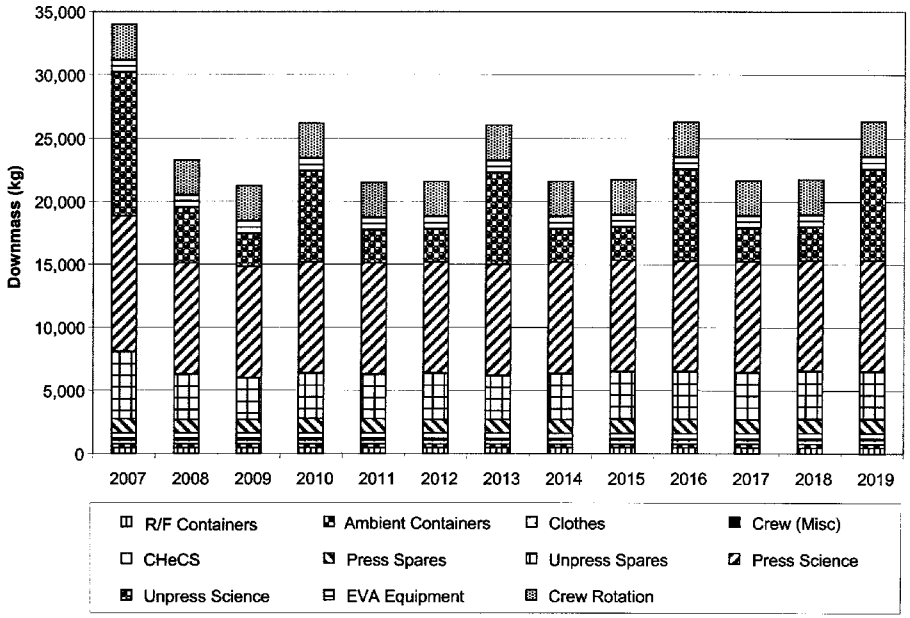
Addl. Crew

New Data	Kg Prop Rqd	Kg Crew Support	Kg Press L&M	Kg Unpress L&M	Kg ** Press Science	Kg ** Middeck	Kg ** Unpress Science	Additional Russian Science	Additional Russian L&M
FY04	5,008	7,540	977	2,618	5,052	1,822	-	2,603	-
FY05	2,384	7,540	1,117	1,828	6,088	2,094	3,547	1,388	
FY06	3,261	7,540	1,258	1,934	7,792	2,094	1,837	3,953	1,200
FY07	2,134	9,633	1,258	4,032	7,638	2,638	4,107	2,515	1,200
FY08	3,084	11,726	1,258	4,032	6,077	2,611	1,900	2,615	1,200
FY09	8,226	11,726	1,792	6,312	6,605	2,584	1,900	2,615	1,200
FY10	5,806	11,726	1,792	6,312	6,605	2,584	3,800	2,615	1,200
FY11	9,191	11,726	1,792	6,312	6,605	2,584	1,900	2,615	1,200
FY12	6,662	11,726	1,792	6,312	6,605	2,584	1,900	2,615	1,200
FY13	4,890	11,726	1,792	4,032	6,605	2,584	3,800	2,615	1,200
FY14	3,000	11,726	1,792	4,032	6,605	2,584	1,900	2,615	1,200
FY15	3,000	11,726	1,792	4,032	6,605	2,584	1,900	2,615	1,200

Note: ** Normalized

ATTACHMENT A-2

USOS Recoverable Cargo Post IP Core Complete



Notes: 1. Numbers not adjusted for Overhead packaging and Flight Support Equipment:
Add Approx 30% for Pressurized Cargo, 100% UnPressurized Cargo **ATTACHMENT B**
2. Post 2016 requirements are for reference only

ANSWERS TO POST-HEARING QUESTIONS

Responses by Sean O'Keefe, Administrator, National Aeronautics and Space Administration (NASA)

Questions submitted by Representative Bart Gordon

Q1. What specific financial arrangements are in place to ensure that all needed Soyuz and Progress vehicles will be available to support the International Space Station (ISS) for a period up to the 32 months that the Shuttle fleet was grounded after the Challenger *accident? Have all of the International Partners agreed to the terms of those arrangements?*

A1. The ISS Multilateral Coordination Board (MCB), chaired by NASA Deputy Administrator Fred Gregory, on February 26, 2003, approved an option to maintain a continued crew presence on ISS until the Space Shuttle is able to return to flight. This option required that the ISS crew size be reduced from three to two, that the April 2003 Soyuz flight be used for crew exchange, and that the Russian Progress flight schedule be accelerated to support crew and ISS consumable needs until the Space Shuttle returns to flight. This option also required the addition of two Russian Progress logistics vehicles to the ISS manifest (one in 2003 and one in 2004) and assumes that the Space Shuttle and the European Space Agency's (ESA's) Automated Transfer Vehicle (ATV) will be flying in 2004. This option was adopted by the ISS Partnership contingent upon provision of funding to the Russian Aviation and Space Agency (Rosaviakosmos) necessary to meet additional ISS support requirements in 2003 and 2004.

Rosaviakosmos has informed NASA that the Russian government is advancing all of the 2003 Rosaviakosmos ISS funding into the first half of 2003 to assist in the acceleration of logistics vehicles. Further, the Russian government will consider providing supplemental 2003 funding in the September time-frame, and also will examine what increases might be necessary for the 2004 Rosaviakosmos budget. ESA, CSA, and NASDA have each made commercial proposals to Rosaviakosmos that are currently being evaluated.

The Russian willingness to provide additional support to ISS during the hiatus in Space Shuttle operations does not require financial compensation under the ISS agreements. The ISS implementing arrangements list the logistics contributions that NASA and Rosaviakosmos plan to provide to ISS. Given that these arrangements were developed on the basis of preliminary estimates of ISS logistics requirements, there are provisions for ongoing adjustment of each party's logistics contributions as the ISS Partners determine actual logistics requirements based on ISS operations.

Q2. If either the April Soyuz crew rotation flight to the International Space Station or the June Progress resupply mission is unsuccessful, what are NASA's specific plans to deal with those contingencies? If funding were available, could Russia accelerate the launch of a backup Progress vehicle if needed, and should NASA make arrangements to ensure that that option is available?

A2. The April 6S Soyuz mission was successfully completed. If the April Soyuz crew rotation mission had not been a success, the Expedition 6 crew would have had to return by the end of May because of the on-orbit time limit certification for the Soyuz capsule.

Had the Progress flight in early June been unsuccessful, NASA would have worked with its Partners to review a range of options, including whether use of consumables by the crew could be reduced, whether the next Progress launch could be accelerated to provide additional supplies or whether the ISS would need to be de-crewed.

Rosaviakosmos has said that with appropriate funding it is capable of accelerating some of the planned Progress resupply vehicles; however, their flexibility becomes more limited as the deadline for procurement of long-lead time items for each vehicle approaches. NASA personnel in the ISS Program Office and in Russia carefully track Russian vehicle production and NASA officials visit Russian facilities to observe the production lines. This type of regular engagement gives NASA significant insight into the Rosaviakosmos vehicle production schedule and clear early indications on Rosaviakosmos' ability to meet planned vehicle requirements.

The ISS Partnership is currently continuing discussions on the technical requirements for, and potential funding of, Progress acceleration and requirements for additional vehicles. Under the terms of the Iran Nonproliferation Act of 2000 (INA), NASA is precluded from procurement of goods and services related to human space

flight from Russian entities unless certain conditions are met. It is NASA's view that current operational requirements are being met by the Progress flight schedule agreed to by the ISS Partnership on February 26, 2003. As the Partnership continues to monitor consumables, the number of required Progress vehicles may be less than required by the February 26 agreement. NASA continues to monitor the situation closely with Rosaviakosmos and our ISS International partners from Europe, Canada, and Japan.

Q3a. If the crew is removed from the International Space Station, how long can it function without a crew? How long will the Space Station remain in orbit without a reboost, and can it be reboosted by a Progress vehicle if there is no crew on the Station?

A3a. The ISS currently has over four metric tons of propellant on board for reboost capability. In the extremely unlikely event of no new propellant deliveries, the ISS could be reboosted to a higher orbit, which could keep the ISS above the 150km minimum altitude limit for up to four years. The Progress Vehicle can be commanded from MCC Moscow to perform a reboost without an ISS crew onboard.

Q3b. What are the critical Space Station systems that must remain operational in the absence of a crew to maintain them, and what is NASA's contingency plan in the event one of those systems fails?

A3b. The critical ISS systems that must continue to operate include: Power, Thermal Control, Command & Control, Attitude Control, and Communications. These systems are redundant such that one single failure would not place the ISS at risk. NASA's Mission Operations has planned for several contingency events with their Russian counterparts and documented contingency actions/responses in the ISS Flight Rules Document. Particular response will always be dependent on which system failed and what is the failure impact on the overall Operational Configuration of the ISS.

Q3c. What specific failure scenarios could result in the loss of the Space Station while there is no crew onboard, and what steps is NASA taking to guard against those scenarios?

A3c. A loss of any of the critical ISS systems, as well as fire or strikes by micrometeoroids or orbital debris, could render the ISS uninhabitable or unusable as an orbiting research facility. In the event the ISS had to operate without a crew for a significant period of time, the ISS program has defined the best operational vehicle configuration (hardware, software and orientation) that will maximize the chances of vehicle survivability while operating without a crew.

Q4. Have you ever discussed either using one of the exemptions permitted under the Iran Nonproliferation Act (INA), modifying the INA, or seeking repeal of the INA with any White House officials up to and including the President? If so, when, with whom, what was the nature of the discussion, and what was the response by the White House official(s)?

A4. NASA has discussed various aspects of INA with other Agencies and Departments within the Administration. Since the loss of *Columbia,* NASA has looked to the ISS Partnership to assist in sustaining human presence on orbit while NASA concentrates on the necessary actions to return the Space Shuttle safely to flight. As such, NASA has been working closely with its International Partners to fully assess the implications of the loss of *Columbia* on ISS operations and to develop and implement an appropriate near-term plan of action. This plan of action does not contemplate modification of INA, use of an exemption or its repeal. Therefore, no such action has been requested.

Q5. Are there any conditions under which you would request an exception to or modification of the Iran Nonproliferation Act to buy additional goods or services from Russia? If so, what are they?

A5. NASA has no plans to seek an exception to, or request an amendment of, INA. The provisions contained within the Act clearly outline the responsibilities and procedures upon which NASA and the Administration can act should circumstances change in the future.

Q6. The FY 2004 budget request is presented in full cost accounting terms, with institutional costs merged with direct program costs.

Q6a. What increases or decreases in the NASA workforce are assumed in the five-year budget projections?

A6a. The FTE Runout in the FY 2004 Budget is:

The FTE Runout in the FY 2004 Budget is:

FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
18,791	18,693	18,491	18,410	18,375	18,356

Q6b. What facility or other infrastructure closings/consolidations are assumed in the five-year budget projections? Please list them.

A6b. NASA has no new infrastructure closings or consolidations assumed in the current five-year budget projections. NASA is preparing a Real Property Strategic Plan (RPSP). As part of this Plan, NASA, with the assistance of an independent national real estate services firm, is analyzing its existing underutilized facilities and land to leverage its value through potential leasing out to third parties or other innovative initiatives, and may also identify future facility consolidations and closures. NASA anticipates the RPSP will be complete in September 2003. Decisions resulting from the RPSP will be reflected in subsequent NASA budget requests. The NASA demolition fund (shown in question 6c below) will demolish facilities that are *currently* abandoned or mothballed.

Q6c. What new investments in facilities or other infrastructure are assumed in the five-year budget projections?

A6c. Most new investments in facilities are through the Construction of Facilities (CoF) program, which is summarized below. The CoF program is primarily repair and renovation of existing facilities, with little new capability or new footprint construction involved. Large investments include replacing older, costly facilities with newer, more efficient facilities at several Centers ("repair by replacement"). The major discrete construction projects are listed below. The CoF program also includes a demolition program for the first time to assist NASA Centers to dispose of aged, abandoned facilities. This fund will demolish over 50 facilities of various sizes.

Total Construction of Facilities (CoF) program:

$M	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	Total
Institutional CoF Projects:	162	174	174	174	174	174	1,032
Demolition:		10	10	10	10		40
Program Direct CoF Projects:	60	64	95	98	61	86	464
Total: Budget (full cost)	222	248	279	282	245	260	1,536

Program Direct Major Construction included in total program:

$M	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	Total
GSFC Space Science Building:	0	0	15	15	15	15	60
JPL Flight Projects Center:	0	0	15.5	21	0	0	36.5

Institutional Major Construction included in total program:

$M	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	Total
ARC Replacement Offices:	0	0	8	0	0	0	8
KSC Space Technology Center:	0	0	0	14	10	0	24
KSC Consolidate Env/Health:	0	0	0	0	0	8	8
MSFC Replace Office Bldg.:	7.3	15.7	0	0	0	0	23
MSFC Replace Bldg 4601:	0	0	8.1	0	0	0	8.1
MSFC Replace Bldg 4481:	0	0	0	17	0	0	17
MSFC Replace Mat. Lab.:	0	0	0	0	22	0	22
MSFC Replace Bldg 4201:	0	0	0	0	0	25.5	25.5

Q6d. What is the size of the current maintenance backlog (in dollars) for NASA's existing facilities and infrastructure, and does the five-year budget plan eliminate that backlog?

A6d. In FY 2003, NASA conducted a fence-to-fence assessment of its facilities using contractor support. This assessment uses a parametric model based on facility inspections and an extensive database of facility repair costs. The assessment cal-

culated facility repair needs and facility condition index. The FY 2003 deferred maintenance is approximately $2 billion. The average NASA facility condition index indicates that NASA's facilities are between "fair" and "good" condition overall. The current five-year budget plan will not eliminate this large backlog of repair; however, NASA's Real Property Strategic Plan will identify strategies for NASA to address this backlog by reducing requirements as well as funding critical maintenance and repair.

Q7. NASA currently has the authority under Title 5 of the U.S. Code to conduct human capital demonstration projects.

a. How many demonstration projects has NASA conducted to date?

b. Please describe each of the demonstration projects undertaken and the results of each.

c. If NASA received the enhanced demonstration authority being asked for in your legislative proposal, what specific demonstration project(s) do you want to undertake?

A7. NASA has not undertaken any demonstration projects to date; however, as the Agency seeks to address a number of human capital challenges, the prospect of using the "demo" becomes more attractive. The current statute governing demonstration projects limits the number of employees who can be covered by a demonstration project to 5,000. Limiting this authority to a segment of the workforce by an artificial number would create a "dual" workforce—with employees in similar positions being subject to different human resources processes and practices—a confusing, inefficient, and potentially demoralizing manner in which to manage the workforce.

NASA has used all available human capital flexibilities to help optimize our ability to attract, recruit, and retain a high quality workforce. We identified additional tools to enhance these capabilities, and are seeking legislation to give us these tools. But we know that we will face additional challenges, and that no one solution will meet all of our needs. The demonstration project authority, with the ability to extend coverage over a significant portion of the workforce (by lifting the current limit of 5,000 employees who may be covered by a project) will be a valuable mechanism to meet new challenges as they arise.

Although we are very interested in testing human capital innovations under the demonstration project authority, we do not have a preconceived notion of the features of the project. Specific proposals would be developed in collaboration with employees, unions, and managers—focusing on those flexibilities that are most needed to address NASA's human capital challenges and achieve the Agency's strategic and programmatic goals.

We have learned from the positive experiences other agencies (including the Department of Defense, the National Institute of Standards and Technology, Department of Commerce, and the Department of Agriculture) have had with their demonstration projects. We may find it beneficial initially to develop proposals similar to some of the successfully tested flexibilities implemented in past and current demonstration projects, tailoring them to meet the specific workforce challenges NASA faces. We are likely to look closely at various compensation and hiring tools that have been used in those demonstration projects.

The demonstration project authority is an excellent way for an agency to develop and propose human resources innovations that are tailored to the agency's specific needs, while protecting important rights. (No waivers of law are permitted in areas of employee leave, employee benefits, equal employment opportunity, political activity, merit system principles, ethics statutes, or prohibited personnel practices.) The goal of such projects is to develop and test new ways of conducting personnel functions or applying human resource systems that are more efficient and effective and thereby contribute to the organization's overall mission and productivity.

Demonstration projects have been used in various agencies for over twenty years to improve personnel management practices and procedures. This approach represents a structured, sound means of "testing" innovations, particularly since it requires ongoing evaluation to assess the effectiveness of the alternative systems. A number of human capital initiatives now enacted into law for all federal agencies—such as the category rating system—were first tested in a demonstration project. We believe the demonstration project authority would be an effective tool for NASA to use in addressing its human capital challenges.

Q8. With respect to recruitment, retention, and relocation bonuses, NASA's 2002 National Recruitment Initiative *report stated that "It is important to note that the payment of these bonuses comes from the Center budget—there is no extra money*

for the payment of these bonuses. Most Center managers said that budget constraints kept them from making use of all of these flexibilities."

[NASA Clarification: The quote from the National Recruitment Initiative report reflects conversations with managers that took place nearly two years ago. One of the values of the study is that it enabled us to identify barriers to successful recruitment. In this case, it is possible that there may have been a misconception among some managers about the funding mechanism for bonuses or the availability of funds, or other funding needs simply may have taken priority. At that time there was no distinct recruitment, relocation, and retention bonus pool. These items were budgeted as part of each Center's awards program. Beginning with the FY 2003 budget, the Centers have broken out the amount to be spent on recruitment, and retention bonuses into separate categories. This change should make it easier to earmark funds available for these bonuses.]

Q8a. How much would each Center's budget need to be increased to allow managers to make full use of these existing flexibilities?

A8a. Each center's budget contains funding for fully loaded FTE's that includes not only the funding for salaries and benefits but also funding for training, awards, relocation costs, and recruitment, retention, and relocation bonuses. In addition, there is usually funding available from the lapse between the time a loss occurs and a replacement is hired. Although individual managers may have felt constrained, the overall center budgets are generally large enough to accommodate funding for recruitment, retention, and relocation bonuses.

Additionally, on the rare occasions in which an organization finds itself in need of additional funds in order to use the new authorities/incentives, that need can be addressed by reprogramming from other accounts. The organization may be able to have funds transferred from unused funds from other elements at the Center. If that is not a viable option, there may be sufficient flexibility to move funding from other Centers to accommodate the organization's request.

Q8b. Under full cost accounting, where will the funds for bonuses at each Center come from? Will a project be taxed if one of the personnel on the project is to be given a bonus?

A8b. Under full cost, all the funding for the enterprise, program or project is combined and all costs are charged back to the cost entity (enterprise, program, or project). Therefore, any personnel costs would be charged to the enterprise, program, and project. This is a change in the way the funding is accounted for but not a change in the total amount of funding or the amount available for recruitment, retention, or relocation bonuses. The same amount of funding for these bonuses will be available under full cost.

Q8c. What determines the size of the bonus funding pool at each Center?

A8c. Each center develops its bonus pool based on projections of future hiring needs and anticipated attrition and labor market conditions.

Q8d. What was the size of the bonus funding pool requested by each Center in each of the years FY 2000 through FY 2004?

Q8e. What was the size of the bonus funding pool actually available at each Center in the operating plans of each of the years FY 2000 through 2003?

Q8f. What was the size of the bonus funding pool requested by NASA for each Center in the FY 2004 budget request?

A8d,e,f. As stated in the response to Question 8a above, beginning with the FY 2003 budget, the Centers have broken out the amount to be spent on recruitment, relocation, and retention bonuses into separate categories. Prior to that they were budgeted as part of the Centers' awards program. There was no distinct recruitment, relocation, and retention bonus pool and, therefore, we cannot identify what specific amounts were requested and available in those categories for FY 2000 through FY 2002.

The values for FY 2000, 2001, and 2002 are the total of recruitment, relocation, and retention bonuses paid out in those years. The FY 2003 and FY 2004 values are the budgeted amounts in the FY 2004 Budget to Congress.

Recruitment, Relocation, and Retention Bonuses
$ Thousands

Center	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
Johnson Space Center	$222	$523	$165	$140	$144
Kennedy Space Center	$120	$339	$108	$150	$150
Marshall Space Flight Center	$13	$47	$44	$49	$0
Stennis Space Center	$31	$115	$10	$75	$30
Ames Research Center	$541	$456	$88	$109	$114
Langley Research Center	$5	$103	$80	$52	$53
Glenn Research Center	$13	$0	$0	$0	$0
Dryden Flight Research Center	$6	$25	$3	$8	$8
Goddard Space Flight Center	$22	$343	$313	$284	$294
Headquarters	$133	$129	$231	$230	$230
NASA	$1,106	$2,081	$1,041	$1,097	$1,023

Q8g. How many bonuses (by category) were offered in each of the years FY 2000 through FY 2002?

A8g. See table, at the end of this question. The numbers representing "offers," however, do not actually represent *all* of the bonuses offered during the indicated year. Not all NASA Centers maintained data on bonus offers declined by individuals, so these Centers reported the number of offers as equal to the number of acceptances. Consequently, the numbers representing bonus offers are artificially low.

Q8h. What fraction of the total amount of the bonus funding pool did that represent in each year?

A8h. As indicated in the response to questions 8d, 8e, and 8f, above, the Agency did not have a distinct recruitment, relocation, and retention bonus pool in those fiscal years.

Q8i. How many of the bonuses were accepted?

A8i.

	FY 2000		FY 2001		FY 2002	
	Offers	Acceptances	Offers	Acceptances	Offers	Acceptances
Recruitment Bonuses	74	67	119	107	60	57
Retention Bonuses	7	7	13	13	9	9
Relocation Bonuses	20	19	30	30	15	15

Q9. What length of time did NASA have a hiring freeze?

A9. NASA initiated workforce restructuring efforts in 1993 when it had approximately 25,000 civil servants at its Headquarters and Field Centers. After intense efforts, the Agency achieved an employment level of under 18,500 at the end of 1998, when downsizing stopped.

Q9a. Since the hiring freeze was removed, how many employees has NASA sought to hire?

A9a. During the downsizing period, the Agency had constrained hiring, but Centers were able to fill critical vacancies. The Agency averaged 160 full-time permanent hires per year. Even during FY 1996, the year with the lowest intake of new employees, 110 full-time permanent hires were made as well as 30 term appointments. In the years since 1998 NASA has hired 2500 full-time permanent employees and

made an additional 250 term appointments. With these hires, NASA has been able to replace attrition and keep the employment level relatively constant.

Q9b. How many positions are still unfilled?

A9b. NASA does not track "vacancies" in the usual sense of maintaining a master list of positions that are either filled or unfilled. When an individual leaves the Agency, we do not automatically refill the position with the same skill set or level. Staffing decisions are based on program needs, competency gaps, attrition levels and available resources.

The FY 2004 budget proposal shows a decreasing civil service workforce in the FTE run out though FY 2008. With declining staffing levels, centers use hiring opportunities to rebalance and otherwise focus workforce competencies on evolving missions. NASA will continue to need to hire 500 to 600 new full-time permanent employees each year to replace employees lost through attrition.

Q10. What is NASA's success rate in filling positions—e.g., how many rejections per acceptance? How does this rate compare to that of the aerospace industry? Of the high technology industry at large?

A10. We tracked the rate of declinations for scientists and engineers for fiscal years 2001 through 2003 and found that the rates for the Agency as a whole averaged five percent for experienced candidates and twenty percent for freshout hires. Freshout acceptances actually declined sharply since last year, from 81.1 percent to only 72.1 percent of candidates opting to come to work for NASA. Several Centers were able to convince only 70–75 percent of their choice candidates to accept job offers. At the Dryden Flight Research Center, which is located in a relatively remote location, managers struggled to gain a 50 percent acceptance rate, even with use of available incentives.

We do not have data to compare these rates with those of private industry. Such information is not made readily available to the public.

Q11. For all of the individuals who either decided to not accept a position with NASA or decided to leave the agency, what were the specific reasons that they gave for their decision? Please provide a breakdown of the total of individuals by category of reason given.

A11. The numbers cited in the above question don't tell the whole story, of course. Our data on acceptances and declinations of job offers over the last three fiscal years do not capture reasons for declination in each instance. However, there are several cases we are aware of that are stunning examples of our need for additional tools to attract top candidates:

- A NASA Center lost a key individual last year—the head of an Advanced Supercomputing Division—to the Los Alamos National Laboratory. The lab offered a salary increase of almost $40,000 and, in addition, the job was located in a much lower cost of living area. This was a significant loss to the Agency; the employee had been with the Agency since 1986, had experience at two Centers, and was highly respected.
- A NASA Center attempted to recruit an impressive candidate for nanotechnology research. He had a Ph.D. in chemistry from Scripps Research Institute and three years of Postdoctoral Fellow research at Harvard University in which he specialized in the development of microfabrication techniques using mesoscale self-assembly. These were competencies highly desired by that Center. Despite being offered a salary at an advanced step of his grade, *along with a recruitment bonus,* he declined the offer due to the high cost of living in that area. NASA's compensation package simply wasn't adequate.
- One NASA Center is in danger of losing one of their brightest recruits in the last two years. The employee has a Ph.D. from Yale University School of Medicine and conducted Postdoctoral Fellow research in DNA sequencing at the Stanford Genome Technology Center. He conducts nanotechnology and DNA/genome research with application to NASA missions such as the development of medical diagnostics, in vivo gene detection and astronaut health monitoring. He is heavily recruited by organizations such as Intel Corporation and by Yale University with starting salaries at approximately $150,000—or more than one and a half times his current salary.
- A freshout Ph.D. candidate from the University of California at Berkeley declined a job offer from a NASA Center that included a salary at the top step of the grade and a recruitment bonus. He was offered a position at Lawrence Livermore Laboratories at a salary almost $20,000 more than this Center could offer.

- Recently, a NASA Center attempted to hire a freshout Ph.D. from MIT who had a background in nanotechnology computing. Despite NASA's salary offer at an advanced rate, *combined with a recruitment bonus,* he declined the offer to accept a position with a small start-up company in one of the Boston high-tech communities.
- A NASA Center lost a high quality employee at the GS–14 level to the private sector. The company raised the person's salary by over 50 percent, bought his house, moved him to corporate housing, helped him buy a new house, gave him stock options, and other perks.

Although we maintain data on losses of employees who leave NASA for reasons other than retirement, our database does not capture the specific reason an employee left NASA. In 2001, NASA conducted a National Recruitment Initiative (NRI) study to develop Agency-wide recruitment strategies to attract and hire a highly, technical S&E workforce. As part of its data collection effort, the NRI study team conducted focus groups at NASA Centers with technical directors, human resource directors, chiefs of employment, recruiters, equal opportunity staff, university affairs officers, hiring managers, and new/recent hires. These focus groups provided valuable information in shaping NASA's current legislative proposals by identifying critical factors necessary to recruit and retain a quality workforce.

NASA has an initiative underway to develop an Employee Preference Survey to better understand "turnover risk" in the Agency. Since this initiative is in the developmental stage at this time, meaningful Agency-wide data are not yet available. The data gathered through this survey are likely to be more accurate than exit interview data in understanding why employees leave an organization since departing individuals often are "guarded" in telling an employer their true reasons for leaving.

Q12. With respect to the Intergovernmental Personnel Act (IPA) assignments: how many IPAs have there been in each of the years FY 1992 through FY 2002? How many of those assignments were to NASA and how many were from NASA? How many of individuals of each category of IPA were extended to four years duration? Of those assigned to NASA, what were their specific responsibilities?

A12.

	ASSIGNMENTS TO NASA		ASSIGNMENTS FROM NASA	
	Total Number of IPA Assignments*	Assignments that were extended to 4 years**	Total Number of IPA Assignments*	Assignments that were extended to 4 years**
FY 1992	26	0	9	0
FY 1993	20	0	11	0
FY 1994	34	2	12	0

FY 1995	30	1	18	0
FY 1996	34	4	11	0
FY 1997	45	3	7	0
FY 1998	85	10	21	0
FY 1999	97	10	4	0
FY 2000	81	4	14	2
FY 2001	80	0	14	0
FY 2002	92	0	18	0

*These numbers represent IPA assignments that were initiated, or extended, in the indicated fiscal year.

**These numbers represent IPA assignments that were initiated in the indicated fiscal year and subsequently were extended to the maximum four-year period.

Below is a summary of the key responsibilities of the IPA individuals assigned to NASA for a period of four years:

1. Provides strategic direction for the Advanced Human Support Technology Program, including the four projects within this Program: Advanced Life Support, Advanced Environmental Monitoring and Control, Space Human Factors Engineering, and Advanced Extravehicular Activity.
2. Serves as Program Scientist for the Gravitational Biology Facility (GBF), the Centrifuge Facility (CF), and the Life Sciences Data Archive at Ames Research Center. Works with science program managers to ensure seamless evolution from ongoing ground and flight research programs to GBF and CF facilities on the International Space Station (ISS). Participates in bilateral and multilateral international discussions to develop and share complementary facilities and synergistic capabilities for life sciences research on ISS. Also serves as Coordinator for U.S.–Ukrainian cooperation in Space Life Sciences.
3. Plans, directs, and coordinates the scientific and operational activities of the NASA Astrobiology Institute. Identifies research opportunities, coordinates efforts involving multiple academic organizations, and communicates the excitement of astrobiology. The Institute represents a partnership between NASA and a number of academic or other research organizations to promote, conduct, and lead integrated interdisciplinary astrobiology research. Also, as Senior Advisor to the NASA Administrator, provides guidance for the newly created Enterprise of the Office of Biological and Physical Research.
4. Assists in scientific direction, development, and management of future Pluto mission as well as the Galileo and Nozomi missions, and the Jovian System Data Analysis research programs.
5. Performs research to develop a global three-dimensional chemistry and transport model for tropospheric ozone and sulfur research. Incorporates the emission, chemistry, dry and wet deposition modules to the current Goddard transport model, and uses the Goddard Earth Observing System Chemical Transport Model to study the natural and anthropogenic contributions to tropospheric ozone and sulfate aerosol levels and the processes controlling those levels.
6. Performs original research in biotechnology, including all aspects of macromolecular crystallography and microgravity research.

7. As project leader for Work System Design and Evaluation (WSDE) within the Computational Sciences Division at ARC, directs the research and development effort in WSDE.
8. Responsible for Human Exploration and Development of Space (HEDS) Enterprise-level education and outreach activities for HEDS science-related endeavors. *[NOTE: The HEDS Enterprise no longer exists. The individual who was assigned to NASA under this agreement no longer works for the Agency.]*
9. Supports the Marshall Space Flight Center effort in assisting state and local organizations with their K–16 math, science, and technology reform programs. Assists in designing, developing, and disseminating math, science, and technology instructional resource materials relating to NASA programs, activities, and results to these partners in the educational community on a regional and potentially national scale.
10. Represents the International Space Station Program before the international and domestic scientific communities. Reviews current space station goals and capabilities with respect to the science community requirements and makes recommendations to the program so that a customer focus is maintained.
11. Serves as Senior Advisor to the Associate Administrator for Aerospace Technology in the area of Space Technology. Provides principal leadership for Bio and Nano Technologies.
12. Assists the Education Office in planning and implementing an overall education program for the northeastern part of the U.S. Programs reflect NASA's GSFC goals and objectives, and are intended to inform educators and students in the areas of science, math technology and training, curriculum development, research and development, and technology applications.
13. As Director of Aerospace at Ames Research Center, plans, directs, and coordinates the technology, science, and development activities of the Aerospace Directorate. The research and technology development efforts include elements such as advanced aerospace projects, aviation systems, space transportation and thermal protection systems, basic and applied aerodynamics, acoustics, and rotorcraft aerodynamics.
14. Assists in the scientific direction, development, and management of NASA programs in solar-heliospheric and cosmic ray physics, and other scientific and educational programs.
15. Collaborates with NASA Education Enterprise to ensure that Human Exploration and Development of Space education programs being developed and coordinated with and integrated into the Agency's overall education programs. Manages the Resident Research Associate program. Works with Office of Equal Opportunity Programs to develop a new Human Exploration and Development of Space technology and education solicitation directed towards minority universities. *[NOTE: The HEDS Enterprise no longer exists. The individual who was assigned to NASA under this agreement no longer works for the Agency.]*
16. Program Manager for the Intelligent Systems program, responsible for structuring the program elements, soliciting proposals, organization review panels, tracking research programs, and reporting program results.
17. Assists in direction of NASA's Space Science Mission Operations and Data Analysis Program; supports oversight of the Deep Space Network and other space operations services at NASA Centers.
18. Assists in the scientific direction, development, and management of programs in High Energy Astrophysics Program. Provides expertise in observational techniques, including new instrumentation and data analysis techniques in a X-ray and gamma ray astronomy.
19. Performs original astrophysics research.
20. Serves as senior high-energy astronomer in the Space Science Department at Marshall Space Flight Center coordinating research of other engaged in theoretical and experimental research related to current space instrument measurements. Performs independent research in high-energy astronomy.
21. Assists the Public Affairs Office in planning and implementing an overall education program from the Northeast part of the U.S. Develops and distributes instructional materials, coordinates and conducts workshops, coordinates conferences, and develops teacher inquiries concerning the program.

22. Serves as Information Power Grid project manager at Ames Research Center. Leads the engineering planning of the IPG testbed and supporting enabling technologies program. Conducts research and development in the area of Internet related security, and secure, policy-based access control for Internet-attached resources.

23. Assists in planning and coordinating efforts for an education/visitors facility. Serves as liaison to the non-profit Foundation to lead this effort. Initiates programs to promote community awareness of NASA and Stennis Space Center educational offerings in support of science and technology.

24. As Director of the Ames Research Center, provides leadership for all research and development programs and the overall management of the Center. Plans, directs, and coordinates research in airspace operations systems, astrobiology and space, and computing.

25. Performs, advises, and coordinates research in the rover autonomy program. The goal of the research is to create a planetary rover system which is able to autonomously navigate across a planetary surface while looking for geologic and biological sites of scientific interest.

26. Assists in the scientific direction, development, and management of the Planetary Astronomy Program and the Near Earth Objects Observations program. Provides expertise in such areas as observational techniques and instrumentation, in situ studies of comets and asteroids, including issues related to sample returns from asteroids and comets.

27. Provides expertise in evaluation Next Generation Space Telescope (NGST) optical systems design and NGST models and tools.

28. Participates in formulation of the advanced information systems technologies for Earth Science Technology Office (ESTO), providing expertise in high speed digital communication, digital processing and adaptive digital signal processing systems for enabling the proper technologies for the Earth Science Enterprise vision development.

29. Plans, designs, conducts, and evaluates experiments involving advanced launch propulsion technologies, such as propellant injection, super-critical spray diagnostics, pulsed detonation engines, and small-scale chemical thrusters.

30. In support of the ARC Advanced Life Support Division, coordinates the development of medical and science support requirements for human life support systems in space. Acts as program scientist for the extended duration orbiter medical research program. As an internationally recognized expert in Space Biology, conducts research jointly with Russian and JSC medical researchers on problems concerning the effects of weightlessness on the skeleton of Cosmonauts about the MIR Space Station. His assignment was extended as development of the ISS began, and to continue critical work on the NASA/MIR research program.

31. Assists in the scientific direction, development, and management of research and flight programs in the Geospace Science cluster and in the Sun Earth Connection theme areas. Provides expertise in fields and particles in situ and remote observational techniques, including instrumentation and data analysis techniques used and proposed for SEC flight programs.

32. As Research Scientist with expertise in the area of deductive synthesis and specializing inference, collaborates with the Ames Research Center Automated Software Engineering Group on research, design, and development of the metaamphion system.

33. In collaboration with senior staff members, responsible for completion of the functional, environmental, and system testing of the plasma instrumentation developed by the Space Plasma Physics group of the MSFC Science Directorate. Oversees the integration of the flight instrument and will leads the mission data analysis effort. Provides technical support to Tether Reboost System study for the ISS; Momentum Exchange/Electrodynamic Tether Reboost technology development program; and Plasma Sails technology development program.

34. Responsible for conceptualizing and developing strategic implementation plans and approaches for Earth Sciences (ES) Enterprise's educational initiative, and aids in implementation and coordination of these plans. Coordinates ES related educational activities with other offices at GSFC. Develops and implements new educational initiatives in collaboration with other programs at GSFC. Rep-

resents ES at selected national and international educational committees, conferences and meetings.

Q12a. Do you have any specific examples of projects suffering as a direct result of the four-year time limitation on IPA's? If so, please describe.

A12a. IPA assignees often are brought in to NASA to work on or manage projects or directly support programs that extend beyond four years. Disruption inevitably occurs in any instance in which an individual with specialized expertise is managing or supporting a project and that individual must be terminated on a specific date without regard to the state of the project at that time.

Since all participants in an IPA assignment are aware of its maximum duration, NASA minimizes potential disruption to the project or research by planning well in advance for transitioning the work to other individuals. Nevertheless, despite such planning to avoid adverse consequences, the ability to extend an IPA assignment at a critical juncture—even for a few months—may permit the project, research, or work to progress more effectively or efficiently.

Generally, there are two situations in which the Agency needs to continue an IPA assignment up to the statutory limit (or desires to extend it beyond that limit): the incumbent provides expertise or talent that is not easily found elsewhere, or there would be a significant return on investment by maintaining continuity on the project or assignment.

The assignment described in #6 above is an example of an assignment in which the individual had exceptional expertise directly related to the work being done.

- The IPA assignee was responsible for performing original research in biotechnology, including all aspects of macromolecular crystallography and microgravity research at a NASA Center as related to the development of NASA biotechnology programs and scientific payloads. The assignee had been an accomplished scientist in macromolecular research at an Institute. She had authored numerous publications in peer-reviewed scientific journals in the area of macromolecular structural biology and had been instrumental in developing innovative instruments for biological research in microgravity. Her continued involvement in the Center's biotechnology work was essential for the development of its Microgravity Biotechnology Program. For example, she developed an independent structural biology research program at the Center that created the first operational microfocus X-ray system for macromolecular crystallography, resulting in two seminal publications and submission of a pending U.S. patent application. Continuing the assignment beyond the inflexible four-year limitation would have enabled the Center to further strengthen its developing Microgravity Biotechnology Program.

The assignment described in #33 above is an example of an assignment in which continuity provided a significant return on the investment.

- The IPA assignee was responsible for conducting research and technology development activities on new methods of supporting human crews in space. The new technologies were required to conform to the current medical and physiological requirements for crew equipment and to future, developing requirements based on specific mission definitions (e.g., for Space Station, MIR 2.) The incumbent had been playing a critical role in the development and implementation of the NASA/MIR research program. At the time of his assignment, the International Space Station (ISS) development had begun but the date for utilization for Life Sciences research had been delayed 6–8 months. NASA needed to extend his assignment to provide the needed continuity on the ongoing development for the ISS at a critical and sensitive stage. His assignment also involved aiding the Agency in its international collaborations with the Institute of Biomedical Problems in Russia and the French Space Agency. Extending his assignment to the four-year limitation provided much-needed continuity to important and sensitive work.

Q12b. Please provide specific examples of NASA projects or activities that require a six-year IPA commitment in order to succeed.

A12b. NASA's position is not that there are projects or activities that require a six-year IPA commitment in order to succeed. Our point is that there are projects or activities that can be accomplished more effectively and efficiently if the IPA assignment can be extended beyond the four-year point, but not exceed six years.

Due to the nature of the work at NASA, many projects have a duration of more than four years. The average length of projects at one Center is seven years; at another Center the average length of projects is five to six years. If an IPA assignee

is providing critical support to such a project due to his or her specialized expertise, terminating the individual in advance of the project's completion (or in advance of completion of key milestones) creates disruption. The following situation illustrates this point.

- Several years ago, a Center reorganized to provide a renewed focus on its technology mission. A nationwide search was conducted to find a person to serve as the Center's Chief Technologist and lead the newly-focused technology mission. An individual from academia was identified as having the unique skills and research background needed to establish a credible research capability for the Center. The individual has made great strides in this initiative, but the effort will require more than four years to be firmly established. As the four year mark approaches, the Center will be required to recruit again for very specific expertise to sustain this major initiative. Having the flexibility to extend the incumbent beyond the four years—but not necessarily for up to a full six years—would benefit the Center and the Agency.

Q13. With respect to NASA's workforce requirements, how does NASA define "critical need," and what explicit criteria will NASA use to determine whether a critical need exists?

A13. NASA does not have a precise definition of "critical need" in the sense of a succinct description that would be applicable to Agency workforce requirements in all contexts. Such a concept would be difficult to develop for any Agency that has a mission characterized by significant program changes and greatly affected by new and emerging technology.

There are a variety of factors that are relevant in identifying critical needs. Among them are: identification of the competencies needed to achieve success in an Agency program; the magnitude of the gap between the required workforce strength in a competency and the current workforce strength in that competency; the percentage of retirement eligibles among the workforce possessing a competency needed by the Agency; the projected turnover rate for a competency; and labor market dynamics relevant to a competency (nationwide as well as Center-specific).

In identifying workforce needs, NASA will consider those factors in conjunction with the Agency-wide workforce planning and analysis capability and the Agency Competency Management System. This system will enable the Agency to track, project, and analyze critical workforce competencies; identify current competency imbalances in the workforce relative to future needs (oversupply/undersupply of key skills); and measure and assess the competency gaps for continuous improvement of human capital management.

To illustrate the point above, a critical need might be identified as a competency in which there was a substantial gap (e.g., greater than 10 percent) between the need for employees with that competency and the competency level within the current workforce. Or, the Agency might identify a critical need in terms of a competency in which all, or nearly all, employees possessing that competency are eligible for retirement.

NASA recognizes that the language in H.R. 1085, the NASA Flexibility Act of 2003, includes a definition of "critical need" and requires the Agency to develop a Workforce Plan that includes a description of the Agency's critical needs and the criteria used to define them. If this should be enacted as written, the Agency will involve key stakeholders in developing a Workforce Plan, including the requisite information on critical needs that fully meets the intent of Congress.

Q14. With respect to term appointments,

a. How many term employees has NASA had in each of the years FY 1992 through FY 2002?

b. Please provide a breakdown of those term employee totals by job category.

c. Of those, how many, if any, have been converted to career employees?

A14a,b,c. The number of term employees by occupation and the number of conversions are shown on the charts below.

NASA TERM EMPLOYMENT BY OCCUPATION FY1992 - FY2003

	S & E	Professional/ Administrative	GS Technician	Clerical	Wage	All Occupations
End of Year -1992	3	4	1	1	1	10
End of Year -1993	10	4	0	8	0	22
End of Year -1994	5	11	0	8	0	24
End of Year -1995	2	2	1	24	0	29
End of Year -1996	10	13	1	60	1	85
End of Year -1997	136	44	5	126	5	316
End of Year -1998	213	86	11	172	5	487
End of Year -1999	83	42	9	86	1	221
End of Year -2000	85	37	9	58	1	190
End of Year -2001	117	40	6	52	1	216
End of Year -2002	81	45	4	51	0	181
May, 2003	73	108	5	59	0	245
	815	432	51	704	14	2016

NASA TERM CONVERSIONS FY1992 - FY2003

	S & E	Professional/ Administrative	GS Technician	Clerical	Wage	All Occupations
End of Year -1992	3	4	1	1	1	10
End of Year -1993	6	9	1	1	1	18
End of Year -1994			1		1	2
End of Year -1995	1	1		3		5
End of Year -1996	12	10		9	1	32
End of Year -1997	122	25	8	22	2	179
End of Year -1998	92	52	7	28		179
End of Year -1999	30	13	5	21		69
End of Year -2000	48	14	1	26		89
End of Year -2001	35	11		18		64
End of Year -2002	12	27	1	11		51
May, 2003		1				1
	361	167	25	140	6	699

Q14d. How many term employees does NASA envision having for each of the years FY 2003–2008?

A14d.

	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
Projected Term Employees	231	333	349	348	404	466

Q14e. If NASA were given the authority provided in H.R. 1085, how many term employees do you estimate would be converted to permanent employees?

A14e. About one third of the current term employees would be converted in any year. The legislation would expedite the process and enable NASA to hire a proven employee.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Sean O'Keefe, Administrator, National Aeronautics and Space Administration (NASA)

Questions submitted by Representative Brad Miller

Q1. Thank you for testifying before the Science Committee regarding the President's FY 2004 budget request. At the hearing, you stated that you believe NASA has technology worthy of introducing and developing in the private sector. You also said NASA does not have the internal expertise to accomplish technology transfer:

". . .We are also looking to—is to utilize the capacity on the part of industry, universities, others to pick up that tech transfer, because in a lot of ways, the last thing we are is really competent at figuring out what commercial applications could come from something. Industry is good at that. Universities are good at that. And so part of our task ought to be to make that information available to figure out how they can then apply it rather than us, the government, public sector trying to anticipate how you can use something for a commercial application. We are singularly unqualified to do that kind of activity, so we are trying to look to industry and universities to partner with us to assume that role in a more dynamic way."

Despite your support for relying on organizations outside NASA to accomplish technology transfer, the Administration's FY 2004 budget proposes to terminate the Commercial Technology program. The program would be reduced to $11.5 million in FY 2004 and would receive no funding in subsequent years. This would have the effect of eliminating support for the regional technology transfer centers and for contractors currently engaged in this work. Given that NASA cannot accomplish this important work internally, why is NASA substantially cutting funding for technology transfer contracts? Please explain the apparent discrepancy between your words and the NASA FY 2004 budget proposal.

A1. The Administrator was discussing a change in focus at NASA, which recognizes that commercial companies are better than government at determining how best to use government technologies in commercial applications. In a constrained budget environment, the Commercial Technology Program, which focused on transferring NASA-developed technology to the marketplace, was not perceived to be providing results sufficient to justify continued support at its previous funding level. As described in the President's FY 2004 budget for NASA, our primary emphasis will now shift from "pushing" NASA-funded technologies on industry, to "pulling" industry in to help NASA develop technologies and applications of benefit to both. Under the proposed Innovative Technology Transfer Partnerships (ITTP), NASA would continue to support essential technology transfer efforts that have been part of the Commercial Technology Program, such as documenting and licensing NASA technologies and making them available for use by the private sector. While the Agency will reduce the amount of active outreach activities to industry, we will conduct a reformulated technology transfer program (ITTP) that relies on vehicles such as e-Commerce and web-based systems to present information on technology that might be applicable for use by the private sector. The National Technology Transfer Center will continue to be one of the resources we use to mission-focused transfer technology to the private sector. The President's Budget also supports a new program, the Enterprise Engine, a pilot project to establish partnerships with private sector innovators and investors that have not traditionally conducted business with NASA.

Q2. The NASA FY 2004 budget would terminate funding for an organization that has consistently proven its value to NASA and to numerous other organizations in assessing commercial applications of new technological inventions. The Research Triangle Institute has repeatedly won a NASA contract (Contract #NAS 1–99134) to provide assessments of the industrial applications and commercial value of NASA innovations. This RTI team, awarded the NASA Public Service Medal as recently as the year 2000, consists of engineers and scientists with a broad range of commercial experience, which have guided NASA in licensing 70 patents in recent years. This team provides just the type of commercial market awareness that you said NASA needs. How much has NASA spent on the RTI contract? To what extent has RTI met or exceeded NASA's performance criteria?

A2. In FY 2002, under the NASA contract with RTI in support of Commercial Technology activities, NASA funded RTI in the amount of $2 million. Beginning with the

FY 2004 President's Budget, NASA has shifted its focus to ensure that technology transfers directly benefit the Agency's mission. As a consequence of this changing focus, the technology transfer functions performed by RTI will no longer be supported. In no way does this change of emphasis suggest that RTI was not performing optimally. On the contrary, RTI has met or exceeded the performance criteria included in the contract.

Q3. You noted that NASA is not terminating all funding for technology transfer. Please explain how the $26.4 million funding designated for technology transfer in FY04 will be distributed. What process and empirical evidence was used to determine how this funding should be distributed?

A3. The $26.4 million for technology transfer in the FY 2004 budget request is the amount required to phase out the Commercial Technology Program and continue to fund:

- the National Technology Transfer Center;
- Small Business Innovative Research and Small Business Technology Transfer (SBIR/STTR) program management;
- and technology transfer statutory requirements.

The $26.4 million request also includes $5 million for the new Enterprise Engine initiative, which is intended to create partnerships between NASA, U.S. industrial firms, and the venture capital community to address NASA's new technology mission needs through innovative technology development partnerships. In addition, the FY 2004 Innovative Technology Transfer Partnerships budget provides $131.4 million for the SBIR and STTR technology transfer programs.

Q4. Would you agree that contractors should be able to compete openly for technology transfer work and that contracts should be awarded to those with the best record of accomplishing technology transfer? Will RTI be able to continue to compete for technology transfer funding based on the FY 2004 budget proposal? If this funding will not be competitively awarded, please explain why not.

A4. NASA agrees that competitive sourcing is the best method of competing NASA work across the U.S. contractor base. RTI will be able to continue competing for any competitively awarded NASA contracts. Due to the program's change in focus, the standard Commercial Technology contract opportunities of the past are not supported the President's FY 2004 Budget, there would not be.

Q5. Many of the field center technology transfer centers already are losing talented, experienced staff after the announcement that they were slated to be dismantled during the next fiscal year. What is your plan for preventing such loss of skill and experience?

A5. With the ITTP, the FY 2004 President's Budget shifts our emphasis toward partnerships that engage in the development of technologies directly beneficial to NASA missions. The departures of any talented and experienced staff as a result of this changing emphasis should not detract from our dedication to retaining and attracting a skilled workforce. We would welcome their talents in other capacities involving NASA.

Q6. As described in the budget, the Enterprise Engine is intended to work in concert with industry and venture capital firms to create new technologies that will benefit NASA. How will Enterprise Engine accomplish this? Do you view Enterprise Engine as a replacement for the current transfer technology programs? If not, how will NASA continue to meet the Congressional mandate for technology transfer with reduced funding for such efforts?

A6. The Enterprise Engine is a pilot project to establish partnerships with private sector innovators and investors to sponsor dual-use technologies to meet NASA's future mission and technology needs. The Enterprise Engine is intended to attract new partners to NASA—innovators and investors that have not traditionally conducted business with NASA. This new concept entails partnerships at the beginning of the process of technology development, taking advantage of existing technologies or the technological capability that exists in the private sector. As part of the new emphasis on technologies that directly benefit NASA's missions, this outside capability would then be channeled to meet NASA's technological needs.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Sean O'Keefe, Administrator, National Aeronautics and Space Administration (NASA)

Question submitted by Representative Zoe Lofgren

Q1. Were there any Shuttle safety upgrade proposals, recommendations, or projects presented to you, either as NASA Administrator or in your former capacity at the Office of Management and Budget that you did not support? If so, what were they, and why did you reach the conclusions that you did?

A1. Administrator O'Keefe has not rejected any Shuttle upgrade proposal as NASA Administrator or during his tenure at the Office of Management and Budget. Since Mr. O'Keefe has been the NASA Administrator, the Administration prepared and submitted to the Congress in November 2003 an amendment to the FY 2003 budget request to increase the funding for upgrading the Space Shuttle system by approximately $660 million for the FY 2004–2008 timeframe. The budget amendment recognized that the Space Shuttle would be the workhorse for International Space Station transport through at least the middle of the next decade.

In 2001, the electric auxiliary power unit (EAPU) was experiencing technical difficulties, cost growth, and schedule delays. This led NASA, with the endorsement of the NASA Space Flight Advisory Committee (SFAC) and the NASA Advisory Council (NAC), to cancel the project in mid-2001. In the FY 2002 Operating Plan, the Space Shuttle program canceled or deferred several upgrades because of cost growth or technical immaturity. In the Operating Plan, reviewed by Congress, the funding made available as a result of these actions was then applied to Space Shuttle operations to accommodate operations cost growth. These actions did not affect safety. In September 2002, NASA's Office of Space Flight canceled the supportability upgrade for the Checkout and Launch Control System (CLCS). The decision was based on: unforeseen development difficulties with software, uncertain confidence in meeting schedule, and significant growth in development and projected operations costs, as well as the fact that this upgrade would not have been significantly more capable than the existing Launch Processing System.

Per the latest update to NASA's Integrated Space Transportation Plan, which extends the Space Shuttle's operational life to the middle of next decade, the Administration's FY 2003 budget amendment increased out-year funding for the Space Shuttle program. This increase provides for an additional flight in support of the ISS and an increase in funding for upgrading the Space Shuttle system of approximately $660 million for the FY 2004–2008 timeframe, through a Shuttle Service Life Extension Program (SLEP).