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NASA Update on the Space Shuttle Columbia

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MR. O'KEEFE: Good afternoon. Thank you all for taking the time to participate in this afternoon's discussion. After conclusion of the opening comments and presentations from myself and Scott Hubbard, we'll have an opportunity to dialogue a little bit here, as we typically do on the update discussions.

Over our 45 years of this great agency's history, we have been defined by our tremendous successes and our tragic failures. In each of these defining moments, our strength and resolve have been, as professionals, have been tested, and this is one of those moments, and it's one of the seminal moments in our history, and I would suggest in the time ahead.

On the 1st of February, we pledged to the families of the Columbia seven that we would find the problem, fix it, and return to the exploration objectives that their loved ones dedicated their lives to.

Today, the Columbia Accident Investigation Board has released its report, and the first of those three commitments has been fulfilled. We're indebted to the Board for their exceptional public service and diligence in this terribly difficult task.

As we begin to fulfill the second commitment to the families to fix the problems, our first step must be to accept the findings and to comply with the recommendations. This report should serve as a blueprint, as a road map to that second objective to fix the problems.

The Board has given us a head start as a consequence of their candor, their openness, and their release of the findings and recommendations during the course of this investigation. So what we read as a result of this report's release

today is what we've heard in the last several months, and they have been true to that objective all the way through.

So we've gotten a pretty good head start I think in developing an implementation plan, and now it must be updated to include all of the findings and recommendations, in addition to the ones we've seen that they released to us, to now incorporate the ones they talked about and are now written and printed as part of this particular report.

The next task is we must choose wisely as we select options to comply with each of those recommendations, and we must continually improve and upgrade that plan to incorporate every aspect we find, as we have found in these last several months, in addition to the Board's findings, in this long road to fulfilling that second commitment to fixing the problem.

Now, the report, as we have heard the Board discuss in the course of their multiple public hearings, press conferences, public availabilities, and their very open discussion of what their conclusions would be, the report covers, as they had said, the hardware failures and the human failures and how our culture as an agency, as a group of people, as a community, as a family, dedicated to these important exploration objectives, need to change in order to mitigate against succumbing to these failings again. It's going to be a long road in that task.

But to describe for you the nature of those findings and recommendations, in very specific terms, we've asked a member of the Board to come join us here this afternoon to walk us through how they have gone about the process of deliberating here in these last seven months on the Columbia Accident Investigation Board, and to summarize those findings, which we will again all be reading here in the days and weeks ahead.

Now, Scott Hubbard is the only member of the Board who is a NASA member of the NASA family, and the rest of the members are from lots of different backgrounds, which he will describe for you. Scott, of course, is the Director of the Ames Research Center out in California and has lots of prior experience in dealing with a range of different programs and managing different activities, to include some of our past failures. So, therefore, he has incorporated and employed those extraordinary experiences in his contributions towards what has been a very, very comprehensive, extremely thorough effort on the part of the Columbia Accident Investigation Board's review.

So, with that, I'd like to ask Scott Hubbard to come join us and to describe the efforts of the Board in the course of this time.

Scott?

MR. HUBBARD: Good afternoon. It's a pleasure to be here with the NASA family. My part of this journey started on February 1st, about 6:30 in the morning. We

were listening to the radio at my house, and we heard the awful news that the Columbia was missing, it was long overdue. Jumped up, grabbed my clothes, grabbed my cell phone, for reasons I cannot fathom to this day why I did that, went upstairs, turned on the television to see what you all saw, which were the pictures of debris flashing across the sky of East Texas.

My cell phone went off. It was my good friend and colleague, Suzanne Hilding, who handed the phone off to Fred Gregory, and he asked me, on behalf of Sean and the Agency, if I would be willing to serve as the single NASA employee on this Accident Investigation Board. I was honored to be asked to do that. I did not hesitate to say, yes.

At 2 p.m. that day, the first telecon of the Board occurred. The next day we were in Barksdale, Louisiana. We began a seven-month odyssey of investigation and learning. The Board operated seven days a week for most of the time. It was a long and thorough effort, I believe, by all 13 members, and at times we got very tired, but every time I looked up in the hallway or in the conference room and saw a picture of the seven members of the crew, we realized that any sacrifice we made would be minuscule compared to the sacrifice that they made.

I'll never forget that moment, a few days after we arrived in Barksdale, when we stood at attention as the helicopters landed with the first crew members who were found. The Honor Guard carried them over to a simple ceremony, and that's when I realized what sacrifice truly means on behalf of this agency and the exploration of space.

I'd like to introduce you now to members of the Board and tell you just a little bit about each one. So, if we could show that slide, actually a series of slides I'll be happy to go through.

First, Admiral Gehman, retired four-star admiral, the Chairman, an extremely capable man. I have a great deal of respect for his leadership abilities.

Next, Major General John Barry. He comes from Materiel Command, Wright Patterson Air Force Base, a real expert in components, materials, aging aircraft. He brought all of that experience to the table.

Next person, Brigadier General Duane Deal from Space Command, Colorado Springs--very familiar with our orbiting national assets, and he brought his knowledge of how that effort is carried out in the Air Force to the Board.

Next, Dr. Jim Hallock is from Volpe Center, part of the Department of Transportation. Jim is a physicist. We bonded right away. He and I had many, many discussions about the physics of this accident, and the engineering, and all of the different technical aspects that we had to investigate.

Next, Major General Ken Hess runs the Air Force Safety Center out in Albuquerque, New Mexico. He has deep experience in aircraft accidents, how they occur, why they occur, and was one of the prime movers in bringing to the Board a broader knowledge of high reliability, high-risk organizations, how they manage risk and so forth.

Next, me. We can skip me and go on to the next one.

Dr. John Logsdon. A lot of you know him. He's an expert in space policy. He's written extensively about the history of NASA, about all of the things that we've done, both the failures and the successes, and he brought his extensive knowledge of policy to the table. And I must compliment John on bringing in an open mind to what we were doing and tried very hard not to let his opinions that he has expressed in writing about policy to influence the conclusions of the Board, that we all signed up to.

Next, Doug Osheroff, a Nobel Prize in physics from Stanford. Doug became well-known for conducting some experiments, first, in his kitchen and then in his laboratory, to demonstrate that some of our ideas about how foam sheds were wrong. In a set of very simple experiments, he showed that notions of what are called cryo-pumping or cryo-ingestion cannot explain the way that foam pops off the external tank. So he made a very substantial contribution in investigation.

Next, Dr. Sally Ride. You're all familiar with Sally, the first woman astronaut. She brought her extensive experience and knowledge of how the astronaut system works, what flying in the Shuttle means, all of the aspects of operations that the Board needed to know in order to evaluate the accident and understand it from the astronaut's perspective.

Next, Roger Tetrault. Roger is former CEO of McDermott, former Chairman of the Board of McDermott Corporation. And Roger brought not only his understanding of business to the investigation, but he also brought some incredibly good engineering skills. He worked on nuclear reactors for a long, long time and truly and well understood what engineering in a high-reliability environment entails.

Next, Real Admiral Stephen Turcotte. He's the head of the Naval Aviation Center. You know that the Navy has aviators, and he brought his experiences and understanding how accidents occur from his perspective.

Next, Steve Wallace is the Director of Accident Investigations at the Federal Aviation Administration. He does accident investigation for a living, and he brought some extraordinary capabilities in evaluating the whys and wherefores of accidents to the Board,

And then, finally, I think there's one more--Sheila Widnall, former Secretary of the Air Force, now a Professor of Aeronautics and Astronautics at MIT. She brought not only her knowledge of large organizations and how they function, from the

DOD perspective, but also a deep understanding of some of our aerodynamic questions.

So, initially, we were eight. We became 13 members within the first month or so, after we were established. We owe a great deal of thanks to 120 staff members that supported the Board, 400 NASA engineers at JSC, KSC and all over the Agency.

We went through 30,000 documents, did 200 interviews, conducted PN public hearings, and all of the time, all of the time, all of the time we had a picture of the crew in every conference room, and we constantly felt that we were serving in their legacy.

This Board was an independent Board. From the very beginning, we had diverse opinions, and no one hesitated to express them at any time. We felt under no pressure from anyone to come to any preordained conclusion.

Now, I'd like to talk just a little bit about the two pieces of the investigation--the physical cause and the organizational efforts.

The physical cause, this was a forensic investigation of unprecedented scale. We followed five analytic paths:

Aerodynamics, looking at how the yaw and roll of the orbiter as it reentered the atmosphere indicated damage in the left wing;

The thermodynamics, understanding the temperatures that were measured over the orbiter and what those were telling us;

The sensor data that allowed us to establish the time line of the accident and ultimately to calculate from first principles how big a breach there had to be in order to come up with that time line;

The imagery, both the imagery on ascent that showed the foam striking the left wing, as well as the many, many dozens of individuals that sent in videos that we were able to use to look at the breakup and understand what was going on;

And, finally, the debris. Twenty-five thousand people searched arm-to-arm through East Texas, recovering 40 percent, by weight, of the orbiter, 84,000 pieces, and that debris told us a great deal. It told us where the breach most likely occurred, it told us where the heat got in, and it told us how the left wing probably failed;

And, finally, the impact tests that I was personally involved in, and I think those showed three things:

One is it provided experimental evidence to support the analytic conclusions; the second thing is that it provided information for future engineering efforts to establish how tough is this material and what are its limits--that effort needs to go on more extensively; and, finally, I think it removed, in anybody's mind, any lingering doubt that foam of that size at that speed can, in fact, damage the reinforced carbon material.

The result of all of this was the statement of physical cause. I won't read it to you. It's in the report. But, in essence, we concluded that a 1.7-pound piece of foam from the left bipod ramp hit the reinforced carbon, Panel 8, 81.9 seconds into the launch, and created a breach that, upon reentry, allowed the superheated air to enter the wing, destroy the wing and ultimately cause the loss of the crew and the vehicle.

You'll notice that we did not include in here most probable, likely. We felt that the preponderance of this evidence, the weight of these five analytical paths, as well as the impact tests, gave us a very high degree of certainty that this is what happened.

But we didn't only look at that. We looked at the organization as well. Now, I should note that the Board studied the Shuttle organization. We looked a little bit at the edges of the International Space Station because it was related in certain schedule issues. We did not look at aeronautics, at planetary exploration, at Earth science and so forth. So the comments in the report, by and large, are directed at the Shuttle program, but I think there may be lessons in there for all of us.

We interviewed 200 individuals, on a privileged basis, so that people would feel free to say what was on their minds and to say what their role or observations might have been in the accident.

We conducted a workshop by the National Safety Council. We brought in experts on high reliability, normal accident and organizational theory, as well as talking to practitioners that work in the fields of managing these types of organizations--the submarines, the Nuclear Navy, the certification for launch that the Air Force uses.

Throughout this analysis and study, we looked, in general, in four areas--the history of the Shuttle, what were the original requirements, what were the compromises, the budget and the workforce changes over the years, decisionmaking, the schedules that the orbiter was placed in, that the shuttle was placed in, in order to meet certain other programmatic requirements.

We looked at this thing called "culture." And I've worked with scientists and engineers for over 30 years, and I can say that if somebody came up to me and said "culture," they would say, "Ah, that's that fuzzy, icky stuff," you know. I didn't take sociology in college. I took physics. I took engineering, something I can get my arms around.

I think the point the Board is making is that the sociological and the psychologic parts of an organization are just as real as the physics and engineering, and how we interact as individuals, how we relate to each other, how we express information to one another, that's part of what we do as well, and that's part of what the Board looked into.

So, as a result of that, we came up with an organizational cause statement, and that's in the report. I won't read it. We put that, the Board, on a par with physical cause, in terms of contributing elements. And we found things that I'm sure you're all familiar with: budget reductions, putting a developmental vehicle, with only 113 flights, into an operational sequence and demanding that schedules meet that. We found some communication problems.

We found the belief, unfortunately, that past success guarantees future success. And when you're dealing with a vehicle where the probabilities of catastrophic failure are perhaps 1 in 200, 1 in 300, somewhere in that range, past success does not guarantee future success.

We found informal chains of command and people conducting discussions in the hallway that had enormous impact on decisions that were made later on.

And we found, at times, a seeming inversion of not prove it's safe, but prove it's not safe. To the extent that this exists, I think that we all need to examine what our approach is to proving that it's safe to fly in anything that we do, whether it be robotic, but particularly in human exploration.

We pride ourselves at NASA as being on the leading edge of science and technology, and I think we are, and we strive to be that every day. There's no reason that we can't be at the leading edge, as we have been in the past, of how to manage high-reliability organizations that deal with very high-risk ventures.

Now, there's a series of recommendations out of all of this. I'm going to walk through them at a very high level. So, if we put up the first recommendation slide.

There are 29 recommendations in all. Fifteen of those are considered return to flight. There are 23 recommendations I would call technical recommendations and 6 that I would call organizational recommendations. The other 14 are considered to be continuing to fly recommendations.

So, if we go to the next chart. Under technical recommendations, there are nine that deal with the thermal protection system. In general, these talk about eliminating damage to the thermal protection system, stopping the foam shedding, understanding the characteristics of the TPS, both by test and by modeling, inspecting this material, both on the ground in as sophisticated a way as we can, as well as being able to inspect it and repair it on orbit, if necessary.

There are four recommendations that have to do with imaging, not only improved imaging on launch, but using national assets to be able to examine the orbiter.

And we have two recommendations with respect to sensors. The Columbia, being the first vehicle, had a very extensive, early set of sensors, and that data which we recovered was very helpful to the Board in reconstructing the accident. The Board believes that we need to maintain and update this capability and add new vehicle health monitoring and engineering performance data so that we understand how the orbiter functions in a much more deep and thorough way.

And then there's a collection of recommendations having to do with inspecting wiring, and testing bolt catchers, having a common definition of what foreign object debris means, having two people present at every close-out and understanding the probability of on-orbit debris and working so that we have a consistent story between what we define for the Space Station and what we define for the Shuttle.

And if there is going to be a decision to fly the Shuttle beyond 2010, it needs to be recertified.

And then, finally, we need to have our photos of the orbiter, what goes on inside of it, as we close it out, as we get ready to fly. Those need to be documented, digitized, retrievable, and in the long term, we need to have very accurate digital Shuttle CAD models so that we understand, should anything happen again, where the part is, and we can retrieve that instantly.

Next, there was a set of organizational recommendations dealing with schedule, training, and then the whole idea of checks and balances, which the Board strongly believes need to be reintroduced.

Scheduling. Fly when you're ready, consistent with the resources that you have;

Training for the Mission Management Team beyond launch and ascent for a full range of contingencies;

And, finally, work with our Safety and Mission Assurance people to be sure they have the kind of authority they need with independent funding;

That the Integration Office for the Shuttle program includes the orbiter;

And, finally, a strong recommendation that for long-term operational ventures like the Shuttle that are high-risk venture, that we separate the pressures of schedule that the program feels from the requirements and the waivers into a different organization, separately funded.

This is a departure, I know, from today's approach, but the Board felt very strongly that this change, which has, in some sense, some cultural implications, would, in fact, create an atmosphere and an approach where the program would not--could

not waive safety requirements. It would have to go to this independent authority in order to secure that waiver. Preparing a plan for that is a return-to-flight recommendation.

These changes will be not only in organizational structure, but probably also require all of us, as managers and executives, to show the leadership that goes along with it.

I'm going to conclude with two sets of thoughts:

First of all, the Board supports exploration of space. The Board supports continuing to fly the Shuttle, subsequent to the recommendations. The Board believes that we have framed the debate for the nation for the direction of human exploration.

These are in three phases: return to flight, mid-term, continuing to fly, and then finally the longer term, where this national debate about the vision for human exploration and for space exploration will occur.

We have, thanks to the leadership of Administrator O'Keefe, I think an extraordinarily good vision and mission statement. This, the Board believes, will help have that vision and mission debated in a national context and hopefully lead to the endorsement of what I know all of us want to do.

NASA is an extraordinary organization. I've been honored to work here the 15 years that I've been a part of this. An incredible people. We do things no one else has ever been able to do, maybe even thought of doing. All of this capability, all of our dreams and aspirations I think can be helped by the recommendations in this report.

I want to comment about where we are in space exploration. We're 50 years into it, but in the first 50 years of aviation, a million airplanes were built, most of them flown several times, and tuned, and tweaked.

In the first 50 years of space travel, we've launched 4,500 times, most of those used only once. We are still in the infancy of space exploration. It'll continue to be a high-risk venture.

Brave men and women risk their lives in the service of science and exploration. We've shed many tears over the loss of the crew of the Columbia. Their best legacy is to continue what we do best to improve and learn from our successes and our mistakes.

George W. Bush said, on February 1st, "Mankind is led into the darkness beyond our world by the inspiration of discovery and the longing to understand. Our journey into space will go on."

I pledge to do the very best I can to make that happen, and I know you will as well.

Thank you.

[Applause.]

MR. O'KEEFE: Thank you, Scott, very, very much for that very thorough summary of where the Board's findings and efforts have taken us at this point.

We're going to go to questions here in a few moments, from both here at headquarters, as well as around all 10 centers, but first I want to summarize and conclude with a couple of comments as well.

First of all, I think Scott's summary or concluding comments and remarking I think on the support that we have received, and the endorsement that we continue to receive from the President, in working through these very, very challenging times, I think should be a source of inspiration to all of us. He has been there every single time at the toughest parts of what this challenge has presented to us.

And just no more than about an hour ago, he released the following statement:

"Today, the Columbia Accident Investigation Board released its report on the tragic accident that claimed the lives of seven brave astronauts. These men and women assumed great risk in service to all humanity. On behalf of a grateful nation, I once again recognize their sacrifices and those of their loved ones. Their service will never be forgotten."

"Our nation also owes its appreciation to Admiral Hal Gehman, as well as the 12 members of the Columbia Accident Investigation Board. As the Board's Chair, Admiral Gehman and his team have worked tirelessly over the past seven months conducting an exhaustive review of the circumstances surrounding this accident."

"The next steps for NASA, under Sean O'Keefe's leadership, must be determined after a thorough review of the entire report, including its recommendations. And our journey into space will go on. The work of the crew of the Columbia and the heroic explorers who traveled before them will continue."

In that spirit, we must go forward and resolve to follow this blueprint and do our very best to make this a much stronger organization. It's going to require all of us, all of us, to participate in this. In the weeks and months that have preceded this date, we have talked about this a lot throughout our NASA family, that we are all, all of us, at NASA, a part of the solution in fulfilling that second commitment to fix those problems, and then ultimately to achieve the third commitment to return to the exploration objectives that they dedicated their lives to.

It's a different NASA today than it was on February the 1st. Our lives are forever changed by this tragic event, to be sure, but nowhere near as much as the lives of

the survivors of the Columbia crew. We must be as resolute and as courageous in our efforts as the families have been in working through this horrible tragedy. They have been a source of inspiration every single moment of every day in working through this challenge.

How we respond in the days, weeks and months ahead will matter as much as what we decide to do and whether it will be a lasting change that will withstand years from now. And, indeed, that's precisely what this Board, and their report, will help contribute to us to achieve.

I started the discussion here for this update with the proposition that, in our 45 years of remarkable history, we have been defined to the American public, and indeed throughout the world, by our great successes and our terrible failures.

In an earlier tragedy, in the immediate aftermath of the Apollo fire, Gene Kranz, the legendary Flight Director who had been involved with the space exploration effort since the early days of Mercury through Gemini, to Apollo, and through the early Shuttle years, after that accident, he had this to say to his team:

"Space flight will never tolerate carelessness, incapacity and neglect. Somewhere, somehow we screwed up. It could have been a design in build or in test, but whatever it was, we should have caught it. We were too gung-ho about the schedule, and we locked out all of the problems we saw each day in our work."

"Every element of the program was in trouble and so were we. The simulators were not working, Mission Control was behind in virtually every area, and the flight and test procedures changed daily. Nothing we did had any shelf life. Not one of us stood up and said, 'Damnit. Stop.'"

"I don't know what the Thompson Committee will find as the cause, but I know what I find. We are the cause. We were not ready. We did not do our job. We were rolling the dice, hoping that things would come together by launch day when, in our hearts, we knew it would take a miracle. We were pushing the schedule and betting that the Cape would slip before we did."

"From this day forward, Flight Control will be known by two words, 'tough' and 'competent.' Tough means we will forever be accountable for what we do or what we fail to do. We will never again compromise our responsibilities. Every time we walk into Mission Control, we will know what we stand for."

"Competent means we will never take anything for granted. We will never be found short in our knowledge and in our skills. Mission Control will be perfect."

That was Gene Kranz's view at that time. That was his charge to all that supported his activities and, indeed, all of NASA's activities in those extraordinary days of great successes which were barely defined as successes because they could have been tragedies, and on that day it was. So they have known, they knew then, the great successes and the great failures that define this agency. And

this is another seminal moment in the remarkable history of this remarkable agency of remarkable people.

We must resolve to be that definitive in our acceptance of our failures and follow through on our commitment to the families to fix the problem now and return to the exploration objectives their loved ones dedicated their lives to.

He concluded, Gene Kranz did, his commentary that day, two days after the Apollo fire, when he said, "When you leave this meeting today you will go to your office and the first thing you'll do is write 'Tough and competent' on your blackboards. It will never be erased. Each day when you enter the room these words will remind you of the price paid by Grissom, White, and Chaffee. These words are the price of admission to the ranks of Mission Control."

I would suggest that we update those words, that we indeed also adopt the principle of tough and competent and that each day when we enter and we do what we do throughout this agency every single one of us ought to be reminded of the price paid by Husband, McCool, Anderson, Clark, Challa, Brown and Ramon. These words are the price of admission to the ranks of NASA and we should adopt it that way.

Let's go to work and let's take a break for a few moments and we'll come back and talk. Thank you.

[Pause.]

QUESTION: In reference to the McDonald Report on the Shuttle wiring and the shortcomings of the program back then, are any of those recommendations being taken into consideration at this time, as well?

MR. HUBBARD: We looked at dozens of previous reports and their recommendations and the 1999 independent assessment team was certainly one of those. The wiring aspect is something that's included in this set of recommendations, particularly to come up. And I know with 17,000 engineers we will come up with a way of investigating wiring where it's inaccessible. This is an engineering issue where it may be deteriorating back there, you can't easily get to it. I'm confident we can find some way to investigate that.

MR. O'KEEFE: Anything else here? Any other questions? We'll come back here in a few minutes, too.

Yes, sir?

QUESTION: In the final minutes before the break-up of Columbia there was decisions going on, there was some analysis going on between Mission Control and the pilots and it would seem to me that they were far from concluding actually

what was going on and I was wondering if any analysis was done on the analysis at that time and what was going on and the urgency and the efficiency of what was being concluded at that time and how far they were actually from knowing what was going on at that time. Were they actually 20 minutes from realizing it before break-up?

MR. HUBBARD: In the report you'll find a detailed discussion of the time line, the discussions in Mission Control, the series of e-mails that had gone on in the background, primarily focussing on a blown-out tire. That's what the engineers thoughts might happen. They saw a temperature rise. Somebody else had been worried about this. What they were focussed on at that point was what would happen if you landed and had a tire that had been blown out due to some overpressure, overtemperature regime.

I don't think at that point that that people in Mission Control realized the other things that were going on. The data was on board the Orbiter. It was not telemetered to the ground . That's something that's in the recommendations. We need to see if we can bring more data to the ground in real time to evaluate what's happening.

MR. O'KEEFE: Let's go to the Johnson Space Center.

QUESTION: Hi. I had a question. The CAIB pointed out that one of the things causing confusion was that NASA didn't know long--didn't have a plan on how long the Shuttle would be flying and I was wondering if NASA had come up with anything on how long we're going to keep the Shuttle around. I know we're working on a replacement, the OSP. What will we do to ensure that that will last over several administrations that it will take to build it in this budget environment?

MR. O'KEEFE: Well, the plan that we had submitted as part of the President's amendment to the budget last November as part of the Integrated Space Transportation Plan was in anticipation of flying the Shuttle for an extended period and that we look at what it would take to extend the service life of that asset to continue not only servicing the International Space Station and finish its completion but also to continue the logistics and operational flights necessary to do so because it is a heavy lift cargo-carrying asset, whereas the Orbital Space Plane or any derivative thereof that may emerge from this, which was also part of that amendment and is now under way and our competitive efforts are beginning to look at what those options will be, is primarily a crew transfer vehicle. It is not intended to be a heavy lift asset or to carry excessive cargo, as the Shuttle was designed and can do.

So the complement of both of those and supplement of both assets is what was envisioned for the longer term and that still is the approach that we seek to take and certainly the findings of the Accident Investigation Board and the assertion made in the report as well as today in the course of its release by the chairman and other members was that the expectation is Shuttle will continue to fly for some

time in the future. Now how long that will be is something we need to continue to assess but it will always be based on the issue of how quickly can we anticipate the acquisition and therefore production of an Orbital Space Plane or whatever derivative that would be the crew transfer vehicle of choice for not only transit between earth and the International Space Station but also to develop the technologies necessary for exploration beyond low earth orbit.

So the opportunities to pursue all those and to really be focussed very specifically on the kinds of characteristics we want that asset to do is going to dictate in the months ahead exactly what kind of integrated space transportation plan will emerge once the deliberations within our administration, as well as the Congress, will yield in that process.

So stay tuned. We've got lots of things coming in the months ahead and certainly I think this Board report has done a commendable job of focussing that debate and giving us a very strong foundation upon which to have that spirited national policy debate in the months ahead.

Let's go to the Kennedy Space Center.

QUESTION: Good afternoon. This is Tom Pentrack from our Space Station and Payloads Processing Directorate.

MR. O'KEEFE: Hi, Tom.

QUESTION: As you know, successful Shuttle and payload processing here at Kennedy requires an effective teaming of both NASA and contractor workforces. While we implement these return-to-flight initiatives, do you expect any significant changes in today's government and contractor teaming arrangements? And furthermore, do you see a change in the role of our NASA Civil Service engineers?

MR. O'KEEFE: That's a good question. Certainly the partnership and the continuing the larger, broader NASA community for space flight operations has been a very successful endeavor and it's one that I think in the course of this report, having reviewed that rather intensively, and I'll ask Scott to comment on this, as well, demonstrates that that is a very workable kind of model and what we've done here.

Now how we may make adjustments in order to again respond to the Board recommendations for a range of organizational as well as management cultural adjustments in the way we look at things for safety, mission operations, the range of different engineering activities, this may portend a different distribution but that's not preordained.

There's nothing that was proscribed. There's nothing that's dictated in this report that says there must be a specific set of options or alternatives selected in compliance with each of these recommendations. We're going to have to really

vet through all those options to figure out what is the right combination? What is the right set of choices of our capabilities for safety, for engineering, for the range of different capabilities we need and then to adopt a very specific set of principles that will define a culture that tolerates absolutely no deviation from that set of safety and engineering standards as we move ahead.

Scott, would you want to commend on that?

MR. HUBBARD: I can add one or two things. One is that the Board spent a lot of time looking into the consolidated contract, the so-called SFOK contract, and we found no evidence--we couldn't connect the dots between that activity and the accident but as you will read in the report, the Board expressed a concern without prescribing what the solution might be at all, about the depth of engineering and safety capability on the NASA side of the fence.

It is an inherently--space exploration is an inherently unforgiving and high-risk venture. It's been said one strike and you're out and there are many places where you need two sets of eyes, not a single one. But the Board did not prescribe what the solution was, left that up to us, to NASA, to figure out the right thing to do.

MR. O'KEEFE: Long way of saying we're going to have to continue to work through that but there's nothing I think that would be a major, major adjustment that that would be portending but it certainly means we've got to look at a range of options that may have some change distributive to the balance or the mix in this larger community of space flight operations.

To the Marshall Space Flight Center.

QUESTION: Yes, a couple of caveats before I ask my question. It may be an apples-to-oranges question. It may be something that is addressed in the report, which I haven't seen. It also recognizes that quality is an extremely complex system and no one system of quality can always guarantee success. But I did take note that this morning the Board did mention quality in relation to the accident. For some time now we at NASA have been deeply involved in something called the ISO process, ISO-9000, ISO-9001. No doubt the agency has put a lot of resources in this particular quality program.

My question is does the ISO quality program have any relationship to the program and the procedures that were mentioned this morning? And is there an ISO paper trail that was useful to you in the investigation?

MR. HUBBARD: Thanks, boss.

MR. O'KEEFE: It's all yours, buddy.

MR. HUBBARD: The Board went through all of the paperwork related to the Columbia and investigated every single anomaly, everything that was written down

as a change order or defect or repair, all of that. The Board members that did that found that some of the paperwork was in very good shape. Other things, such as getting the right set of drawings that were updated very quickly were a problem and that's the genesis of the recommendation of having digitized close-out photographs need getting good CAD models, computer-aided design models, and so forth.

The Board did not look at ISO-9000 except there is one comment in the report that ISO-9000 came from an industrial background and what we do is research and development, but we made no conclusions one way or the other about the adaptation that we do.

MR. O'KEEFE: To the Stennis Space Center.

QUESTION: Good afternoon, Administrator O'Keefe. Allen Mader.

My question is with release of the report, do you think that this will have an effect on astronaut recruiting, particularly with the educator-astronaut program?

MR. O'KEEFE: As a matter of fact, the astronaut office and the Flight Crew Operations Directorate, Bob Cabana as the director there, has recently come in to lay out the procedures for the recruitment of the coming class here, likely to be late this year or early next, which will be the first class in three years, almost four. So the objective is to start working at very specific kinds of disciplines and professional qualifications.

He's not looking at a large class that may even--it won't even be a fraction of what the numbers were in '96 and '98 relative to that but he very specifically in laying out that particular strategy and we've signed off on that plan, lays out that specific approach to recruiting specific disciplines. And among those disciplines are a specific requirement for educator-astronauts.

Again recall that the way that we created and set up the requirements for educator-astronaut is that they, all candidates, much like Barbara Morgan, as they move through this particular astronaut training program and candidacy and then ultimately through the advanced training effort, will go through precisely the same training efforts in order to be fully qualified for every dimension of duty aboard any individual flight or International Space Station in the task of fulfilling those particular responsibilities.

So there is no distinguishing feature in the disciplines between and among any of the different disciplines or professional series if you will within the astronaut corps and the educator-astronauts, just like Barbara Morgan, are completely involved in every single aspect and dimension of that training.

So we'll be looking at a smaller class but one that very specifically will fill the kind of discipline requirements that we have in the time ahead for the astronaut corps overall, to include educator-astronauts, as well.

To the Ames ReSearch Center. That's a place that you're looking forward to getting back to. Would you like to ask a question?

QUESTION: Scott and Sean, this is Mark Cohen. We met at Ames about a month ago. I'm president of the Ames Federal Employees Union, IFPT Local 30 and my question pertains to two trends that we have observed in the agency over a period of a decade or more, which is the devaluing of technical and engineering expertise and competence on the one hand and on the other hand, the ever-increasing pressure to out-source, contract out, privatize, and turn things over to the private sector.

My perception of what happened during the course of this sequence of events that led to the accident is that we had alarms and alerts coming from in-house NASA engineers but the Shuttle program management preferred the soothing but superficial and ultimately misleading viewgraphs from the contractors to the technical concerns of the in-house people. I see this as occurring in a climate where NASA management sometimes tends to disdain our own technical competence as a kind of endangered species and prefers any opportunity to throw the money over the wall to the contractors.

Did the Accident Investigation Board consider this set of trends and the environment it creates within the agency?

MR. O'KEEFE: Well, it sounds like you've made up your mind already. The approach I think that we're trying to do I think at this point and will emphasize as part of our--as I mentioned in my comments, the Board has been extremely forthcoming all the way through the investigation and very open and very candid about what direction we're heading. And in the process of doing so, it gave us a really, I think, enormous head start in the process of looking at the kind of corrective actions we need to make.

Among them is the establishment of the NASA Engineering and Safety Center, which will be United States government employees, public servants, engineers and a range of other disciplines who'll be charged with the task of being removed and independent from each of the program management activities, as it were, but looking at trend analysis in a variety of different efforts to assure that we're not overlooking the anomalies, not becoming I think accepting of things we see repetitively and instead doing the testing, doing the kind of review, and that's going to call for, I think, some rather extensive, very talented professional technical talent that's resident within this agency now.

So in the days and weeks ahead you're going to see a lot more of General Roy Bridges, who now has taken the lead in the directorship at the Langley Research

Center, working to try to develop and recruit through all of our centers the folks who are interested in and very anxious to be part of this Engineering and Safety Center. And to the extent we've got to add additional personnel to that, that's what we're going to do.

So as time marches ahead here, I think we'll see lots of different examples of that and moreover, I think Scott's point, which again I'll defer to him in just a second here, that he made just a few moments ago is in looking through the history of this--as I recall it, it was seven or eight years ago--in which the space flight operations contract was converted at that time, their review of that particular activity as a contractual matter did not suggest that there was any absence of diligence from anybody associated with the larger, broader space flight community in this particular case.

It was more a question of do we have the adequate depth--and I think this is your point, Mark--in engineering and technical talent in order to really cover these kinds of additional requirements like the NASA Engineering and Safety Center? And we'll be seeing that in the days and weeks ahead as we're looking to recruit the folks that stand up that organization and make it as tough and as competent, as Gene Kranz would suggest, as we know how to make it. And therefore make sure that every single program we're engaged in, not just space flight but across every parameter, everything NASA does, that's going to be the purview of this organization and they will be public servants like all the rest of us here.

Scott, do you want to comment on that?

MR. HUBBARD: Maybe just to add one or two things, which is I think you hit the nail on the head. It's checks and balances, some depth on the bench. In the time that the administrator alluded to where I got to come here to NASA headquarters and reconstruct the Mars Program after those failures, one of the things we looked at is whether there was adequate attention to the off-nominal, to the unexpected, whether or not there was enough resources being put into evaluating not just the success-oriented main path you were on but the side lobes, you know, the places where the gotcha's can occur.

And as a consequence, we, in fact, added some more effort to that kind of activity and I think that's what the engineering center and this independent technical authority can do, is to take the time, since they don't have the schedule pressure, to go and look at some what-ifs, to go and evaluate materials characteristics and have that kind of depth on the bench that will enable us to really understand these developmental vehicles.

MR. O'KEEFE: Let's go to Dryden.

QUESTION: My question has three parts to it. Number one is Admiral Gehman's committee and all the various panels of experts that they had, this kind of impartiality and the ability to stand back and look at critical issues within NASA

concerning the Space Shuttle, is that impartiality, maybe that panel is going to be maintained over time or is another panel going to be created to take their place, or are they just going to stay with it?

The second part is all of the recommendations and all the suggestions that Admiral Gehman's committee came up with, are they going to be implemented in their entirety by NASA or is NASA going to pick and choose what they want to take from that recommendations?

And if they are going to be accepted in their entirety by NASA, are the results of NASA's efforts to comply with that, are they going to be made public over time after each and every issue is addressed and resolved?

The third part is it sure was nice to hear the comments of Gene Kranz. I wonder if we're going to hear more from him over time.

MR. O'KEEFE: Well, thank you for that. I've had to take notes here to make sure I get every part of your question and I appreciate the thought to this. You're emulating some of the journalists I have an opportunity to interact with from time to time and that's a very fine characteristic.

The Board's future. Admiral Gehman early on in this process observed in public testimony on several occasions that their approach would be again to reach findings and recommendations and that findings be statements of fact and that the recommendations would be to describe the corrective actions that must be taken but not to prescribe in a dispositive way, in a very specific way, here's what the corrective action must look like.

It's his view that he expressed in public testimony in press conferences and everything else over the course of several months was that the Board's responsibility was to look at what led to the accident, find the problem, the first of that commitment that I talked about, and to therefore lay out what the blueprint or the road map would be in order to correct those problems, but that it would be NASA's responsibility as management and as all of us as part of this family, to make the choices about the options that we think are best in order to comply with those recommendations because we have to implement it and we have to live with it and be responsible and accountable for the results of it.

And his view was, and he expressed it again repetitively in several public forum, was that having a group describing in great detail exactly what the organizational or mechanical or hardware change or technical fix would be and then leaving or not being responsible for its implementation would be the worst of all worlds.

So he has been very specific about saying their objectives would be to reach those statements of fact and determination of fact and findings and describe what needs to be done, what needs to be corrected, and make it very much our responsibility at NASA to make the choices a best effort at determining exactly what those

options should be, what the best options are in order to fully comply with those recommendations.

So their view is that as of today, with the exception of Admiral Gehman and some staff, the rest of the Board is going to go back to their regular lives. They've been at this since February 1 nearly 24/7. I mean this is an amazing effort, a very exhaustive investigative activity that they've engaged in and they've been focussed exclusively on those two points--finding the facts, coming up with a recommendation on what needs to be corrected, so therefore not looking at longer-term implementation plans. They've directed that that is our responsibility and we must be accountable for that activity.

So from this day forward it is our task to carry forth. He will stay--Admiral Gehman will, the chairman--for some weeks ahead in order to appear before members of Congress. Lots of committees would like to spend time with him and me and others throughout this agency and from around the community, so he will be the principal witness for the Board in the weeks and months ahead as the Congress goes through its particular review. Then at the conclusion of that activity he intends to go back to peaceful, blissful retirement, which is where he was interrupted from when I called him on the afternoon of Saturday, February 1 and said, "You're going to work 24/7 from this day forward until you finish the report" and he gratefully accepted that challenge and thank God he did because he really did a remarkable job with his 12 colleagues I think in working through this.

To the second part of your question, do we intend to comply with the recommendations? You bet. Without reservation. The time for debate about this has been done. We've had seven months. There's been lots of hearings. This has been a very open, extremely, very extensive investigative process. And public testimony has been taken from lots of folks within our agency, lots of folks external to the agency, anybody with an opinion. I mean it's been a very, very thorough endeavor. And every one of those 20 odd hearings were the better part of four hours long.

So we've had plenty of opportunity in public debate to engage in that discussion. We've had lots of opportunity working with the Board every single day in providing the analysis to support the investigative activity, to offer our view, our judgment, our opinion, whatever. It has been had. We've gone through it and I've talked about this at every center in the several weeks and months that have preceded this point of saying we have really engaged in a very fulsome debate about this.

The opportunity now to debate these points is now closed. The issue of how we go about picking the options to comply with these recommendations, each one of them, is going to be our charge from this point forward and that's a position I think we really must take with great conviction, accepting the findings and complying with the recommendations. And again knowing that we have the responsibility to select options that will comply with those recommendations that will be fully

compliant in that effort and that means we really have to choose wisely. We have to be very careful in selecting that.

So in that regard as part of your first question, too, what will take over from here are folks who have not become wed to a particular solution. Again Admiral Gehman offered the view that one of the other reasons why the recommendations are not dispositive or directive in terms of how we actually go about compliance is that every member of the Board, with all deference to our friend Scott and all of his colleagues, all have a favorite way they'd like to have seen it implemented, for which there was no consensus or couldn't be a consensus on precisely what the approach should really be.

So they would have spent a lot more time actually converging on 13 different consensus positions among 13 people on exactly what the right approach would be. So instead, that's our responsibility, is we have to implement it. We have to own it. We will be accountable for what we choose to do, all of us in this agency, in making that choice.

So in order to make sure that we are thorough in our treatment of all of the options for every one of the recommendations, we've asked Tom Stafford, certainly a veteran astronaut of the Gemini and Apollo era and has been a continuing source of guidance and statesmanship to us for many, many years. He and Dick Covey, who was the pilot on the return to flight after Challenger in September of 1988, the two of them will co-chair a task group of 27 different members of external players outside this agency who are academics, engineers, technical folks, management experts, all manner of different experiences that each of these 27 people bring to this, to help us make sure we choose wisely what each of those options should be to comply with those recommendations.

So the Stafford-Covey team is now going to take over as the external reviewing authorities with no sense of ownership or proprietorship or any fondness for any individual option, as the Board may have or as we may have, in dealing with these recommendations. They're going to come to this with a completely objective view.

They've already met once. They got together in early August. They'll meet again next month and we'll be meeting with them regularly as we go through every one of these findings and recommendations and a number of things that we within NASA have come up with as requiring of full implementation prior to our efforts to return to flight or that we'll alter down the road or better improvements to the management, as well as conduct of operations for every NASA program from this point forward.

So the Stafford-Covey team and the task group that they will be co-chairing will be looking over our shoulder and helping us arrive at the right kind of solutions of which are the best options, which are the best approaches to comply with those recommendations fully and I fully expect they're going to be a very opinion-driven

bunch because they all come from different backgrounds, much as the Accident Investigation Board did.

And they were selected specifically because of their expertise in each of those individual disciplines and we certainly could add additional members if there are other dimensions of things we come to find we need more expertise to deal with.

So in that regard, you bet. I think the professionalism, on your third question, and the dedication to service, as well as what I found most impressive about Gene Kranz's tenure and his career is a very strong sense of community, a very strong sense of family, of how we have a direct responsibility for everything it is we do within this agency and we take it personally as our charge to be responsible and accountable for those activities. He really recognized that and really recognized the activities of teamwork in the dimension or the particular activities that he spent his career dealing with. It's a model to emulate in other areas that we sort our way through. There's no question he is one of the heroes of the NASA culture and history that we all ought to be justifiably proud of and those are the parts we ought to emulate most.

Sorry for the long answer but it was a very thoughtful three-part question.

To the Langley Research Center.

QUESTION: Good afternoon, Mr. O'Keefe, Scott. This is Mark Sanders.

MR. HUBBARD: Hi, Mark.

QUESTION: You mentioned the NASA Engineering and Safety Center and I mean presuming that this is our response to the Board's recommendations on the independent technical engineering authority. Do you see any additional systemic organizational changes that the agency needs to make to help us take advantages of the recommendations for all of us to do a better job and work better together?

MR. O'KEEFE: That's possible. Certainly again there's a very strong view, I think, among the Safety and Mission Assurance folks, from Brian O'Connor very specifically, I think, that we cannot do anything that's going to ever relieve any program management team or any of us, any of us, of the responsibility for safety in the way we consistently conduct our activities.

So any idea of trying to sever these functions would inadvertently establish some form of absolution on the part of all the rest of us except for those who are charged with safety activities. We want to avoid that.

So in our efforts to put together the NASA Engineering and Safety Center, we have to be absolutely diligent, very committed to assuring that we not disrupt that responsibility, that all of us must feel deep in our souls as a responsibility for safety in the way we conduct business and that we do it professionally but, at the same

time, that we have an organization that has the capability to look at things objectively, removed from a little bit of a distance, and look at, over time, the kind of trend analysis efforts that are necessary to do the testing that's necessary, the kinds of things that are not driven by day-in and day-out operational imperatives in any program that NASA manages and is responsible for.

So in working through that, there may be additional changes in that regard or more that is an outgrowth of that to bolster the engineering or bolster the safety capabilities within our organization and within each of the programs that may emerge from this.

So the one point I think to your question, Mark, is to focus very specifically on let's get the NASA Engineering and Safety Center under way and within the next 30 days or so that's our intent, is to have that door open and in business, to start the process of all the things that are included in the Engineering and Safety Center's charter, and then let's build on that experience to figure out what other expertise or what other capabilities we need to bolster throughout all of our programs and activities across the agency.

And to the Goddard Space Flight Center.

QUESTION: Sir, with respect to our organizational causes--we have a horrible echo here--this is an R&D outfit. I have been doing a lot of work in math and computer science that I feel is directly relevant. How can I suggest things to address Chapter 7 issues to you or to staff? In general, how are you going to handle out-of-the-blue suggestions from the employees?

MR. O'KEEFE: That's a great point. There are a number of different ways that you go about enjoining on this question and let me just enumerate there or four that come to my mind right now. There are going to be lots more and we'll see if we can get something out here that will very specifically detail the avenues and directions because we want to hear from anybody and everybody as we work our way through this, so we make sure we do it right and that we all have a sense of ownership of those results. I think that's imperative that we do so.

This is not about space flights, not about the Shuttle program. It's about NASA overall.

So I'm delighted that you've got the interest in participating in that regard in wanting it to go forward. So let me just enumerate three or four ways.

The first one is the Return-to-Flight Task Group is now being chaired, and has been since March, as we've begun this process developing the implementation plan, by the Associate Administrator for Space Flight, Bill Readdy, and by Michael Greenfield, who is the Associate Deputy Administrator for technical programs.

And the two of them are looking at the overall conduct and coordination of all of the different teams that are involved in this. Colonel Jim Halsell is the primary

program responsibility, if you will, of the Return-to-Flight Team down at Johnson, but all of those activities between the Readdy-Greenfield effort is to coordinate these kinds of activities to be sure that this all gets infused in as well.

So those are at least two avenues there through the Readdy-Greenfield Team, through Office of Space Flight or through the Associate Deputy Administrator for Technical Programs Activities, any ideas that may be attained there, certainly through those two avenues, as well as through Jim Halsell's approach. There are specific aspects that pertain specifically to the activities of return to flight. That's where you stop there as well.

The third approach would be at the Goddard Space Flight Center. Al Diaz has his door open all the time, from what I remember, as the Center Director there. He's anxious to hear what's involved. We're all anxious to hear of what's necessary in order to move forward, and he is extremely receptive and very interested in any ideas that come from anybody in order to move forward with that approach.

Again, the NASA Engineering and Safety Center, as that stands up in the next 30 days, will be a great repository for that, and our intent is to--this is a fourth avenue that I can think of, off the top of my head--is to put the overall monitoring of the NASA Safety Reporting System, the NSRS effort, throughout the NASA Engineering and Safety Center. And that gives another avenue for the purpose of defining good ideas, good approaches, good ways to do business that are really focused on how we can do business better in this particular regard.

So choose your avenue, which one you want, and we'll also try to get more information out through each of the Center Directors on how everybody can participate in this. We'll try to see if we can solicit as wide a participation as possible, and certainly we want to hear everybody's approaches, suggestions, and participation in what is really an agencywide function and set of challenges that we need to conquer. And given the history of this remarkable agency, I have no doubt that we'll do it with great skill and great consistency, as we work our way through this, but we must commit ourselves to that task.

So I'm delighted to hear you're interested in that approach.

Tony is waving at me saying that I've got to at least pass on to you, as well, that there are two other avenues for gaining information on the accident investigation report.

The first one is through the Accident Investigation Board itself. There is www.caib.us is the website for the Accident Investigation Board and lots of different information there, as well as now, as of this morning, we have posted the final report on the NASA website. So www.nasa.gov is where we can access the report as well.

So a combination of both of those should give everybody access to everything that's out there, as well as, over time now, in the next few weeks, as the additional volumes of backup and appendices, and so forth that complete this effort, this is the report itself, and then all of the backup material that goes with it will be published as well. All of that will go up on the websites as well in time.

So what we've seen right now is the findings, and recommendations and the specific results of this very definitive work over the course of the last seven months.

Let me just conclude, I guess, with my thanks and appreciation to Scott Hubbard for your tremendous public service on this Board. He was among that 13 folks who didn't see any prospect that his life was going to be disrupted as it was on February 1st and for every single day thereafter. I think he's looking forward to the challenge of getting back and leading the Ames Research Center, and we're really very pleased. So, as of today, he has got that charge, and he's on his way to reassuming that important responsibility that he has done so exceptionally well, and we know that he'll pick up from this.

But I think the contributions that Scott has made, as well as will continue to make as part of this, will be an even stronger set because of this great experience. And it's one that I know we can count on him for that remarkable insight, as well as assistance in working through these challenges.

To all of us, though, I think we all have a responsibility, and I think the very clear message that I heard from Scott's commentary, as well as from what I've seen in the report and my discussions with Admiral Gehman this morning as he delivered the report, is that the importance of exploration and the task and the quest we dedicate ourselves to professionally, every single day, have been reaffirmed by this Board.

Indeed, Admiral Gehman's view that he had mentioned in the press conference was that if they spent the time writing about all of the good things that they see about what's so remarkable about this agency, it would have been a huge report. Instead, their charter that I asked them to do when I commissioned them on that morning, that morning, within two hours of this activity, and they had their first meeting by 5 o'clock that day on the 1st of February, was to look at what caused this accident. That was their focus.

And so as a consequence, they really honed in on that question, instead of dwelling on all of the other things that involve the activities around the Agency, although, again, he offered us how there are lots of extraordinary things that they have found, that they were privileged to be part of and to see and witness in terms of our extraordinary professionalism and the things that we are engaged in and that we should, and the American public, in his statement, should be very proud of what it is we do.

Well, they endorsed that exploration objective and that quest for what we have been founded to do, and we continue our charter in pursuing those particular objectives.

And the second thing they found very clearly is there isn't any reason why we should not continue to pursue those objectives, using this capability and other capabilities to achieve those exploration objectives in the time ahead.

So those issues, having really been resolved as a matter of this, our responsibility, again, that I find absolutely the most compelling of all, is to those seven families we owe them our best effort to assure that we fix those problems--the second part of the commitment--and that we return to the exploration objectives that their loved ones dedicated their lives to.

That's something we want to take very seriously, we ought to take to heart, and we need to believe it as we work through all of these findings and recommendations to assure we do our very best at it.

And as I started my commentary, if history is any guide, this too will be a seminal moment in our history and one that, when we look back on, we should be very proud of our professional response to it, and I have no doubt that will be true.

I thank you all for the time, and I thank you, Scott, for joining me today. I appreciate it very much.

[Applause.]

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