STRATEGY FOR SAFELY RETURNING SPACE SHUTTLE TO FLIGHT STATUS

HEARING

BEFORE THE

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

OF THE

COMMITTEE ON SCIENCE AND TECHNOLOGY HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

SECOND SESSION

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CONTENTS

WITNESSES

STRATEGY FOR SAFELY RETURNING SPACE SHUTTLE TO FLIGHT STATUS

THURSDAY, MAY 15, 1986

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, DC.

The subcommittee met, pursuant to call, at 10 o'clock, in room 2318, Rayburn House Office Building, Hon. Bill Nelson (chairman of the subcommittee) presiding.

Mr. NELSON. Good morning. The subcommittee will come to order.

In the months since the *Challenger* accident, this subcommittee has held hearings on the budgetary and programmatic impacts of this tragedy. We've explored the actions of the administration and the Congress, which actions we'll have to pursue in order to maintain assured access to space.

Now we think that we have reached a point in time that we have to start exploring what must be done in order to safely return the shuttle to flight status.

As in our past hearings, these hearings today will not investigate the *Challenger* accident. We made a decision in this committee, along with our colleagues in the Senate and the House in all the committees that have jurisdiction over space, that we were going to let the Rogers Commission do its work unimpeded, recognizing that that was in the best interest of the country, that we identify what the problem is so we could get upon the task of correcting the problem, and thus we will not be entering into the arena with regard to the *Challenger* accident here, even though these hearings are on the subject of flight safety.

Now these hearings are necessary so that we continue to have an effective line of communication between NASA and the Congress rather than having the information flow back and forth purely on the basis of press reports. We continue to believe that it's in the best interests of the country that these proceedings be conducted in a manner that is totally open to the public. We think that that's the best way in which we can air this subject that obviously so many people have so much interest in.

Now we understand, having talked to a number of you privately, that NASA's current recovery planning is based on success-oriented schedules, so that if problems are encountered, delays naturally are going to be the result. We believe that this is the proper way to approach the current national emergency in space launch capacity.

On the other hand, we want to make sure that, regardless of a set schedule, that safety and reliability are not sacrificed even though we all know how absolutely necessary it is for us to get back into the space launch business as soon as possible for many, many reasons, not the least of which is national security.

We want to make sure that there is sufficient time, that there is the sufficient funding that is properly allocated to fully resolve any and all safety or reliability issues as we move toward that date that we all look forward to, which is when we can soar into the heavens again.

So the focus of today's hearing is going to be on the strategy for safely returning the space shuttle to flight status.

Now today we're going to have testimony from Dick Truly, who is the Associate Administrator for Space Flight; from Jesse Moore, Director of Johnson Space Center; from Arnie Aldrich, the Manager of the National Space Transportation Systems at JSC; from John Young, who is Chief of the Astronaut Office; from P.J. Weitz, who is his Deputy; and from Bob Crippen, who is Deputy Director.

We're going to also hear from members of the Aerospace Safety Advisory Panel. It's an organization of outside experts that has responsibility for advising the NASA administrator on the safety aspect of all of the manned flight programs, and people that will be on that panel are John Brizendine, who is the Chairman; Mr. Parmet; Mr. Grier; Mr. Himmel; and Dr. Krone.

So I want to thank you all for being with us today, and I'd like to ask my ranking Member, Mr. Walker, for his comments.

Mr. WALKER. Thank you, Mr. Chairman.

I want to join you in welcoming our witnesses before the committee today. We have many friends here, and together I hope we can make some important progress toward improvement of flight safety in the future of the program. This hearing will be our first major step in reviewing NASA's progress toward our mutual goal of safe manned flight.

I've read your memo, Admiral Truly, and your testimony. I applaud your calm and reasoned approach to the problems that we face. In fact, I think it will be crucial that there be a strong and steady hand at the helm, and I assure you that you will have my full support as we proceed along, trying to get us back flying.

It's important that we remember that flight safety is more than a motto, it must be a way of life within NASA. Quite frankly, I've been deeply concerned about the pattern of safety and quality control problems that have become public in recent months.

We are not going to examine the *Challenger* accident here today. We agree that the proper forum for that discussion will come after the Rogers Commission reports. The intent of this hearing is to resolve future concerns, not the past. But, as is inscribed on the National Archives, those who do not learn from the past are doomed to repeat it.

There is a pattern of problems, if ignored, that we will pay for in the future. We must make certain that safety practices are not violated at any point in the future. We cannot continue to have the kinds of concerns within the agency and publicly about whether or not safety is given the top priority in the NASA Program.

We also need to face the fact that we must not impose artificial pressure on the system. In the past, we have all been guilty of pressing for artificially high launch rates. Congress, NASA, OMB, and the media have all shared in pressing for higher rates that cannot be safely sustained. I urge you to resist that pressure in the future.

Today we will also address the question presented by flying the shuttle *Centaur* in the payload bay. I admit that I am still deeply concerned about this question. When we were faced with the national policy that limited the United States to the STS as our only launch system, it was a risk we were forced to accept. Today we are obviously returning to a mixed fleet. Since we are going to be forced to accept a delay in both the *Galileo* and *Ulysses* missions, it seems to me that it is sound public policy to carefully reexamine that risk.

Finally, Mr. Chairman, I want to examine with our witnesses the possibility of incorporating representatives of the Astronaut Office into the Mission Management Team with formal responsibility for flight safety.

Mr. Chairman, this committee remains committed to a manned space program. For more than a quarter of a century, more Americans have carried the fire of manned space exploration of this universe. The finest memorial we can fashion to the crew of the *Challenger* is a vibrant and revitalized manned program that will quickly return us to flight status with the risks minimized.

Thank you, Mr. Chairman.

Mr. NELSON. Thank you, Mr. Walker.

OK, we'll proceed, and, Admiral Truly, we'll start with you. Then we'll go to Mr. Aldrich, and it's my understanding Mr. Moore—do you need——

Mr. ANDREWS. I just wanted to make a few comments.

Mr. NELSON. Yes, sir, Mr. Andrews.

Mr. ANDREWS. Thank you, Mr. Chairman.

I want to thank you and applaud you for calling this hearing this morning to have an opportunity to review plans to renew the shuttle operations. We prepare for this action safely and prudently, and I think these hearings are going to be a very important part of that.

These have been very difficult days for all of us who appreciate the importance of the national space effort. From the professional engineer at the Johnson Space Center to the pad technician at the Cape, to every member of the House and Senate committees, there is certainly a fervent and enthusiastic desire to set the space transportation system right and move it forward again.

I think Admiral Truly's strategy, as outlined in his May 24 memo, is a good one and a good starting point. This subcommittee needs to study each of his proposals carefully.

This framework, I think, that you've set for us, Admiral Truly, has real merit, and I look forward to it. I think it's going to put us on a path toward safety and put us on a path toward returning to space at the earliest possible time.

And I do want to say that I'm delighted to see John Young here. He and I were judges at a chili cook-off Saturday, and we tasted 30

different kinds of chili, and I survived. John Young made a meal out of the contest, and I'm glad that he is here and well.

Thank you, Mr. Chairman.

Mr. NELSON. OK. Thank you, Mr. Andrews.

All right; let's proceed. It's my understanding that Mr. Moore does not have a statement, so we'll go from Admiral Truly to Mr. Aldrich and then to Mr. Young. So let's proceed. Thank you.

STATEMENTS OF RICHARD TRULY, ASSOCIATE ADMINISTRATOR, OFFICE OF SPACE FLIGHT, NASA, WASHINGTON, DC; JESSE MOORE, DIRECTOR, JOHNSON SPACE CENTER, NASA, HOUSTON, TX; ARNOLD ALDRICH, MANAGER, NATIONAL SPACE TRANSPORTATION SYSTEMS, JOHNSON SPACE CENTER, NASA, HOUSTON, TX; ROBERT L. CRIPPEN, DEPUTY DIRECTOR, FLIGHT CREW OPERATIONS, JOHNSON SPACE CENTER, NASA, HOUSTON, TX; JOHN W. YOUNG, CHIEF, ASTRONAUT OFFICE, JOHNSON SPACE CENTER, NASA, HOUSTON, TX; AND PAUL WEITZ, DEPUTY CHIEF, ASTRONAUT OFFICE, JOHNSON SPACE CENTER, NASA, HOUSTON, TX

Admiral TRULY. Mr. Chairman, I'm pleased to be here and with this group today to address the issue—the main issue of this hearing, which is flight safety.

Since the *Challenger* accident on January 28 and about a month later when I took the present position at NASA Headquarters as Associate Administrator for Space Flight, I think no other single issue has been more on my mind than to try to create an environment in which we can return to flight and we can return in a manner that makes us all confident and comfortable with the space shuttle system, which is one that I think this Nation should be extremely proud of, and I have spent every moment since then in one way or another toward that goal.

As you know, one of my jobs is as the chairman of the NASA task force to do the accident investigation, and I want to report to you as a status that the investigation, in my view, has gone extremely well. I think if Chairman Rogers were here, he would tell you that our task force has supported him from the very start. I believe that, as I have testified earlier, that they will probably conclude that there was a chain of events, as there are in most accidents, that caused this one.

Technically, we have narrowed the causes in the field joint of the solid rocket motor to a small and finite list, and our direction to the redesign team is to make sure that their fix, when it is determined—and it has certainly not been decided yet—would solve every one of the potential causes that the commission has uncovered.

The other job that I've had is to try to create a way for us to return to flight, and, as you have mentioned, about a month and a half ago I did publish what, in my mind, was a strategy which would give direction to the system as to what to do, leaving to Arnie Aldrich at level 2 in Houston to determine most of the how-to-do-it, and he'll be prepared to tell you about that today.

But throughout the fabric of this strategy is flight safety. We have set a success schedule to get back to flight that will have a

first flight in July 1987. There is schedule risk to that. There is probably some cost risk to that because we have not yet decided—in some critical items there may be other things we need to fix.

But I can assure you there is no safety risk to that schedule. If we get one quarter through it, or one half, or three quarters, and discover that we have a problem that will make the shuttle not up to our standards on flight safety, we will not launch and we'll delay further.

This strategy covers a broad number of areas that I'd like to just touch on the titles of, but I think you'll get a good rundown from Arnie in his summary.

We're going to reassess the entire program management structure and organization, including from the design requirements, right up through the launch commit criteria and the commit to flight.

We have a solid rocket motor joint redesign team that is in place and working. We're going back through all the design requirements for the shuttle, not just for the solid rocket motor but for the whole system. We are reviewing the critical items list that we've heard so much about and the paperwork that supports that. We essentially are recertifying every critical item in the system.

We are reviewing the paperwork that the Kennedy Space Center uses to process vehicles as they prepare for flight. We are doing a reassessment of the regime in which the *Challenger* was lost, and that is the launch and abort phase of the flight, to look at our mission rules that come in many varieties.

The second major area that we did was, we outlined some guidelines for the first flight which are conservative and safe, I believe, but still will allow us to launch a major and important payload, and some guidelines to allow the system, not me personally but the mission planning system, to plan a year of—the first year of safe flight.

And, finally, we have initiated an effort that is in work and, frankly, will take a bit longer to come to a final conclusion, but the objective of which is to set a safe and sustainable flight rate for the shuttle in the future so that we can plan a flight rate that we all believe in and believe that we can make.

We have a mountain of work to do. The work has already started. In almost every area that has come to light and is being discussed I think this strategy embodies ways that each of the concerns can be met, and we're extremely pleased to be here today and tell you where we stand.

Thank you, sir.

[The prepared statement of Richard Truly follows:]

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Subcommittee on Space Science and Applications
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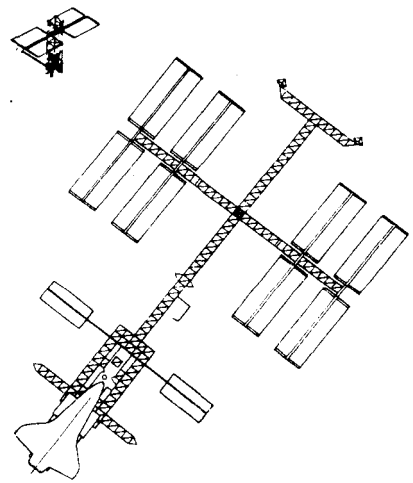

Statement by:

Richard H. Truly
Associate Administrator
for Space Flight

99th Congress

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PRESENTED BY WITNESS

MAY 15, 1986

Statement of

Richard H. Truly
Associate Administrator
Office of Space Flight

National Aeronautics and Space Administration

before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
United States House of Representatives

Mr. Chairman and Distinguished Members of the Subcommittee:

I am happy to accept your invitation to testify before this Subcommittee about the Office of Space Flight plans for recovery and the steps we are taking to ensure a safe and successful return to space for the Space Shuttle.

The Space Shuttle is the most complicated and technically sophisticated vehicle in the world. To build it required engineering knowledge at the forefront of technology and engineering breakthroughs. It has capabilities that are totally unmatched anywhere in the world. While it is probably the most reliable space transportation vehicle in the world, one-hundred percent reliability for such a vehicle was and is an impossibility; however, we must and will do all we can to maximize safety and reduce the risks.

Safety is obviously not just a function of hardware; it is a function of care, of emphasis, of environment, of training, and of communications. The NASA team of civil servants and contractors

care deeply about the work they are doing and will be doing, to make the Shuttle safe. We are restructuring the environment in which we work to further emphasize the methods by which technical and safety concerns are considered, and to identify early and ensure we properly address program-wide safety issues.

Although a detailed and very specific assessment of all the impacts of the accident upon our programs will not be completed until later this month, we can specify the impacts in general terms. These impacts may change as a result of the accident investigation, but at a minimum include the loss of an Orbiter and associated onboard hardware, the need for a complete review of all procedures and hardware systems affecting flight safety, implementation of necessary system modifications, and a flight hiatus of at least a year.

Our primary emphasis continues on the right Solid Rocket Booster (SRB) aft field joint. Major tests are in process at Morton-Thiokol and at the Marshall Space Flight Center (MSFC) to better understand the joint characteristics in various conditions. We are also destacking the SRB at KSC to analyze the effects of stacking on stack joints. Salvage operations have recovered several pieces of the suspect joint, including a portion of the aft segment which contains the failed joint. These pieces are being prepared for failure analysis.

A dedicated Solid Rocket Motor (SRM) joint design group has been established at Marshall Space Flight Center, with selective participation from other NASA centers and external organizations, to recommend a program plan for the SRM joint redesign. This plan will include the type and content of post-flight inspections for the redesigned joints. Other flight components will be developed in detail, with criteria developed for commitment to the next launch as well as reusability of the specific flight hardware components.

Two of the most important factors in training our astronauts are the Shuttle training aircraft and the flight simulators. The astronauts, in their testimony before the Presidential Commission, noted every astronaut who flew the Shuttle has complimented our Shuttle Training Airplanes (STA's), which are modified Gulfstream II's, because the STA's were real preparation for the rigors of flight. Similarly, they valued the time spent on the Shuttle Simulators (SMS) and expressed their support for continuing with our efforts to obtain a fourth STA and support upgrading the Shuttle Simulators so that sufficient time was available to train the large complement of astronaut pilots.

As we know, simulations and design are not sufficient to test the full capability and demands placed on the marvelous sytem we have. Some of the conclusions about the flight environment and knowledge of limitations of the Orbiter can be obtained only from actual flight and landings. Because of the knowledge obtained from flights, a redesign of the nosewheel steering mechanism was

initiated last year to make it failsafe. The new carbon brakes designed for the Orbiter are another of the changes we had not originally anticipated but which are in process.

My major focus these first few months has been the investigation of the STS 51-L accident. The President appointed the Presidential Commission on the Space Shuttle Challenger Accident on February 3, 1986, to review the circumstances surrounding the accident, to establish the probable cause or causes of the accident, to develop recommendations for corrective or other action based on the Commission's findings and determinations, and to submit its final report within 120 days.

The STS 51-L Task Force at Kennedy Space Center, which is analyzing the accident, is managed on a day-to-day basis by my Vice Chairman, Dr. J. R. Thompson. This task force includes six teams including a development and production team, a prelaunch activity team, a mission planning and operations team, an accident analysis team, a salvage support team, and a photo and TV team. There is also a strong NASA/Commission interface in Washington, D.C., which includes a Headquarters action center. This center formalizes all Commission requests for data, analyses, and reports; and maintains status of task force activities. Currently, for example, they are tracking over 300 Commission action items. In our review to date, the task force has focused on the physical evidence from salvage operations; on launch related data analysis including weather effects, photographic evidence, integrated loads analysis, and the mission events timeline; on the manufacturing and assembly processing of hardware; on the launch pad, and on the cargo. The task force teams and subteams reported to the Commission on April 18; the Commission's report to the President is due the first week in June.

We are following a comprehensive strategy that, when completed, will allow resumption of the flight schedule. NASA Headquarters particularly, the Office of Space Flight, the OSF centers, the National Space Transportation System (NSTS) program organization and its various contractors have been given guidance to proceed with the realistic, practical actions necessary to return to the NSTS flight schedule with emphasis on flight safety. This guidance is intended to stabilize planning activities for the first year of flight while putting in motion the activities required to establish a realistic and an achievable launch rate that will safely sustain the Orbiter fleet. This strategy states that we intend, in general, to fly the first year of operations within our flight experience. If, for example, we have flown the engines at 104 percent, we will exceed the 104 percent criteria only after very thorough safety reviews.

The NSTS program management philosophy, structure, reporting channels and decision-making process will be thoroughly reviewed and those changes implemented which are required to assure confidence and safety in the overall program, including the commit

to launch process. Any system is only as good as the data that flows through the system. The system we are designing will require that matters of critical importance are provided for decision, and that the decision process filters out neither too little nor too much information.

A review of the NSTS Design Requirements is being conducted to insure that all systems design requirements are properly defined. All Category 1 and 1R critical items are being subjected to a total review with a complete reapproval process implemented. Those items which are not revalidated by this review must be redesigned, certified, and qualified for flight. Category 2 and 3 CIL's will be reviewed for reacceptance and to verify their proper categorization.

The Operational Maintenance Requirements and Specifications Document (OMRSD) will be reviewed to insure that the requirements defined in it are complete, and that the required testing is consistent with the results of the Critical Items List (CIL) review. Inspection/retest requirements will be modified as necessary to assure flight safety.

The launch and launch abort rules, and philosophy will be assessed to assure that the launch and flight rules, range safety systems/operational procedures, landing aids, runway configuration and length, performance, abort weights, runway surface, and other landing related capabilities provide an acceptable margin of safety to the vehicle and crew. Additionally, the weather forecasting capability will be reviewed and improved where possible to allow for the most accurate reporting.

The planning for the flight schedule for the first year of operation will reflect a launch rate consistent with this conservative approach. The specific number of flights to be planned for the first year will consider KSC and VAFB work flow, software development, controller/crew training, etc. Changes to flight plans, ascent trajectories, manifest, etc., will be minimized in the interest of program stability.

The most important step in resuming this Nations' leadership in space is to identify the problems which led to the Challenger accident, to design and implement fixes for these problems, to assure flight safety when we return to Shuttle flight activity, and to expand upon the base of experience we have developed.

Our Nations' future in space is dependent on the individuals who must carry this strategy out safely and successfully. The Space Shuttle program will only succeed in the future if the talented and dedicated men and women who fly the Shuttle have confidence in the system we design.

Mr. Chairman, this is the end of my prepared testimony. I appreciate this opportunity to appear before you today and would be pleased to answer any questions you may have.

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David W. Garrett
Headquarters, Washington, D.C.
(Phone: 202/453-8400)

For Release:
Feb. 20, 1986
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TRULY APPOINTED SPACE FLIGHT ASSOCIATE ADMINISTRATOR

Rear Admiral Richard H. Truly, USN, Commander of the Naval Space Command, has been appointed Associate Administrator for Space Flight, NASA Headquarters, effective immediately.

Truly will head NASA's Space Shuttle program and will assume direction of the agency's Design and Data Analysis Task Force which is reviewing the Shuttle Challenger accident of Jan. 28, 1986. In both roles, he succeeds Jesse W. Moore.

Moore will assume the post of Johnson Space Center Director, an appointment that was announced on Jan. 23.

Truly was designated a naval aviator in 1960. His initial tour of duty was in Fighter Squadron 33, where he flew F-8 Crusaders and made more than 300 carrier landings. From 1963 to 1965, he was first a student and later an instructor at the U.S. Air Force Aerospace Research Pilot School, Edwards Air Force Base, Calif. In 1965, he was among the initial military astronauts selected to the USAF Manned Orbiting Laboratory program. He became a NASA astronaut in 1969 and spent 14 years with NASA.

Truly was pilot for one of the two-man crews that flew the Shuttle Enterprise approach and landing test flights in 1977. He was then assigned as backup pilot for STS-1, the first orbital flight test of the Space Shuttle. His first space flight was STS-2 (Nov. 12-14, 1981) as pilot of the Shuttle Columbia. He was commander of STS-8 (Aug. 30-Sept. 5, 1983), the Shuttle Challenger, the first night launch and landing in the Shuttle program.

Truly became the first commander of the Naval Space Command upon its commissioning on Oct. 1, 1983. The Command is responsible for management and operational control of all Navy satellites in use and provides direct space system support to the fleet worldwide.

After attending schools in Fayette and Meridian, Miss., Truly enrolled as an NROTC midshipman at the Georgia Institute of Technology in 1955. He received a bachelor of aeronautical engineering degree and was commissioned an Ensign in the U.S. Navy in 1959.

Truly has received numerous Defense, Navy and NASA awards. He also is the recipient of the Robert H. Goddard Memorial Trophy, the Thomas D. White Space Trophy and the Robert J. Collier Trophy.

Truly is married to the former Colleen Hanner of Milledgeville, Ga. They have three children.

- end -

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Mr. NELSON. Thank you, Admiral.

Mr. Aldrich.

Mr. ALDRICH. Mr. Chairman and distinguished members of the subcommittee, thank you for the invitation to testify before the subcommittee this morning regarding the National Space Transportation activities keyed to the safe resumption of space shuttle operations.

I've submitted a fairly lengthy statement which covers activities leading to first flight with particular orientation of safety and also a delineation of a number of the program activities underway in support of the program during this period. This morning I'd like to highlight that statement in submitting it by covering those items directly related to the safety reviews that we're conducting and ancillary activities.

In response to Admiral Truly's direction on safely returning the space shuttle to flight status, I have initiated programwide activities to fully implement Admiral Truly's actions. Specific lead assignments and status are summarized as follows:

First, as Admiral Truly pointed out, a solid rocket motor redesign team, headed by Mr. John Thomas of the Marshall Space Flight Center, has been put in place in residence at Marshall, consists of approximately 75 people from both within and without NASA. Their preliminary work to date has concentrated on the analysis of a wide range of potential design fixes.

Preliminary analyses so far support a potential delivery of redesigned and retested SRM flight segments to KSC in the March–April 1987 time frame, and this is the basis for the July 1987 first flight projection which we're working toward.

Second, a space shuttle design requirements team is headed by Mr. Jesse Goree of the NSTS Systems Integration Office at JSC. It has been assigned to re-review all of the NSTS design requirements and the associated technical verification of those requirements. This team will focus on each space shuttle project element and on the total space shuttle system design requirements themselves. This activity will culminate in a space shuttle Delta Design Certification Review of the total program approximately 3 months prior to the next space shuttle launch.

Third, as Admiral Truly pointed out, we have instigated a complete re-review of all space shuttle program failure modes and effects analyses and associated critical items lists. Mr. Bill McCarty, the NSTS manager for safety, reliability, and quality assurance, at the Johnson Space Center in my office, has been assigned to lead this activity, and each space shuttle project element and their associated prime contractors are conducting separate comprehensive reviews which will culminate in a programwide review with myself later in this year.

Technical specialists from outside the Space Shuttle Program have been assigned as formal members of each of these reviews, and as they progress, all prior criticality 1 and 1R items have been voided and the teams are required to reassess and formally resubmit for approval any waivers in these categories which are recommended for continued program applicability. This activity will culminate in a comprehensive final review at NASA Headquarters with Admiral Truly.

The fourth item is a programwide re-review of all space shuttle test, checkout, operations, and maintenance requirements. It's being conducted under the leadership of Mr. William Fischer, NSTS Systems Office at JCS, and here again we're placing particular emphasis on identifying and scrutinizing test requirements in the program that deal with criticality 1, 1R, and 2 hardware items. This activity is scheduled to be completed late in this year, is closely coupled with the FMEA critical items reviews and the reviews of the Kennedy operations and maintenance instruction procedures.

Along that line, a fifth item, a comprehensive review of those procedures at KSC is underway under the leadership of Mr. Robert Sieck, the Director of Shuttle Management and Operations at KSC. The activity includes a full technical re-review of all shuttle processing procedures, paperwork, and requirements.

In addition, this review is responsible for developing closed-loop controls between the FMEA critical items, the operations and checkout requirements, and these checkout procedures. This activity is also expected to extend through this year and be finished in the early 1987 timeframe.

A launch/abort reassessment team has been established under Mr. Jay Greene of the Flight Director's Office at the Johnson Space Center. This team is re-reviewing space shuttle launch commit criteria, flight rules, operational crew procedures, space shuttle ascent design, landing site selection and characteristics for abort and normal end-of-mission landings, and the design and requirements for the space shuttle range safety system and its associated procedures.

Teams have been established also to coordinate programwide assessments, analysis, and planning to define the schedule and characteristics for the space shuttle first flight and to develop projected first year and sustainable long-term flight rates.

The first year flight definition team is headed by Mr. Edwin Hoskins, head of the Flight Integration Office at JSC. The flight rate team is headed by Mr. Alfred Bishop, Deputy Manager of Mission integration at JSC.

As a result of this work, the program has recommended a first flight date of July 15, 1987, as Admiral Truly has pointed out, and recommended a cargo of a tracking and data relay satellite for that first flight. Also, several manifest options for the entire first year have been developed and proposed to Admiral Truly as have first year and sustainable long-term flight rate assessments.

In addition to the reviews outlined above in direct response to Admiral Truly's strategy and action for returning the space shuttle to flight status, there are a number of other critical program activities which I would like to briefly describe.

Shortly after the *Challenger* accident, I felt it was necessary to constitute a series of formal reviews to reassess known areas of technical risk across the Space Shuttle Program elements. In this regard, in March I initiated a series of senior management special program control review board meetings to consider space shuttle system areas where safety margins are a concern. This board is chaired by myself; membership includes the project managers of all NSTS program elements and their contractor counterparts, the

Johnson Space Center's directors of space operations and research and engineering, and the head of the Astronaut Office.

To date, 96 different potential safety concerns involving orbiter, external tank, and space shuttle main engine hardware and software have been considered. Of these, 44 are of a level of significance that improved hardware, software, processing, or operations may likely be required before resuming flight activity.

Forward action paths are underway on each of these items, and appropriate action has been assigned. Technical improvements which are deemed not critical to first flight are also being aggressively pursued as potential downstream enhancements to space shuttle safety, performance, and operations.

Board meetings to consider safety concerns involving the Kennedy Space Center launch facilities and the Vandenberg launch facilities will be conducted in the near future. Solid rocket booster safety concerns are currently being addressed separately in the solid rocket motor redesign team at the Marshall Center that I mentioned previously.

In association with other analyses of the STS 51-L accident, a special review of space shuttle crew egress and escape provisions has been initiated under Mr. Allen Louviere of the JSC Research and Engineering Directorate. The scope of this analysis will cover the total mission and flight profile, which includes onpad, launch, ascent flight to orbit, and descent from orbit to landing phases. To analyze each aspect of the mission, design teams for ground egress, bailout, ejection, water landing, and powered flight separation have been established, and a systems engineering team is in place to maintain steady continuity and integrate the results of the proposed system concept studies.

The initial team activities are in progress with a preliminary report scheduled to me by June 15, 1986. From these data and preliminary assessments, it is expected that the most feasible concept to be studied further will be selected. This study will consider modifications to the existing STS system and also concepts which might be included in future space shuttle vehicles.

At the time of the STS 51-L accident, the STS *Centaur* hardware was well into its test program, and resulting design issues were to be reviewed at a second Delta certification review scheduled for the February 1986 timeframe.

Subsequent to the accident, JSC and the Lewis Research Center have initiated a comprehensive re-review of the *Centaur* vehicle and associated missions, and have defined a series of modifications which should be made to enhance both *Centaur* and orbiter safety on these missions.

In addition, a series of studies and reviews were implemented to ensure that currently defined systems, processes, procedures are adequate to control the hazards associated with *Centaur* shuttle operations. These studies and reviews are scheduled to be completed in September 1986. However, currently a complete reassessment of the residual risk of shuttle *Centaur* operations is underway, and results will be presented to Admiral Truly on this subject in the near future.

Planning is also continuing for the Vandenberg launch site activity required to conduct special tests of the shuttle vehicle and

ground facilities late this year. These tests include vehicle and launch mount structural characteristic definition, shuttle-to-facility interface verification, and a demonstration of liquid oxygen and liquid hydrogen tanking. The tests are being structured to provide early verification of Vandenberg activation and therefore provide a maximum time for any related problem resolutions so as to minimize subsequent requirements for the first Vandenberg launch flow.

To support these early tests, the program plans to ship *Columbia* to Vandenberg in September of 1986. Subsequent facility tests with *Columbia* will be conducted utilizing currently available filament wound case solid rocket booster hardware which will have to be substituted downstream for their first flight with redesigned filament wound case solid rocket boosters.

Finally, in consideration of the number, complexity, and interrelationship between the many activities leading to the next flight, I have initiated a series of formal program management reviews for the National Space Transportation System. These reviews are structured to be regular face-to-face discussions involving the key managers of all space shuttle program activities and will be chaired by myself.

Specific subjects to be discussed at each meeting will focus on the progress, schedules, and actions associated with these major program reviews that I've described, and each meeting will be tailored directly to the current program work for the time period involved.

The first of these meetings was held at Marshall on May 5 and 6, and it proved to be a very effective session for the total program elements. Follow-on reviews will be held approximately every 6 weeks, and I'm planning to have the next meeting in the week of June 16 at the Kennedy Space Center.

Mr. Chairman, this concludes a summary of my testimony, and I appreciate this opportunity to appear today and will be pleased to answer other questions related to this activity.

[The prepared statement of Arnold Aldrich follows:]

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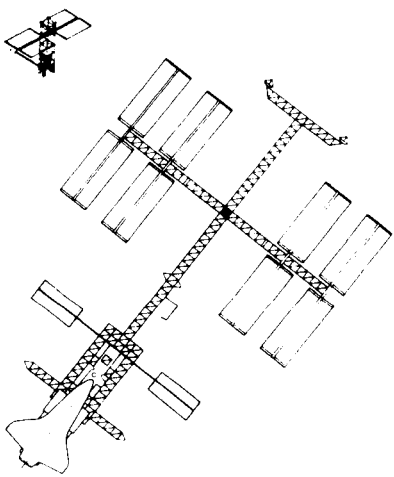
May 15, 1986

Subcommittee on Space Science and Applications
Committee on Science and Technology

House of Representatives



Statement by:

Arnold D. Aldrich
Manager
National Space Transportation System

99th Congress

HOLD FOR RELEASE UNTIL
PRESENTED BY WITNESS

MAY 15, 1986

Statement of

Arnold D. Aldrich
Manager
National Space Transportation System

National Aeronautics and Space Administration
Johnson Space Center

before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
United States House of Representatives

Mr. Chairman and Distinguished Members of the Subcommittee:

Thank you for your invitation to testify before this Subcommittee regarding National Space Transportation System activities keyed to the safe resumption of Space Shuttle operations.

In response to Admiral Truly's direction on safely returning the Space Shuttle to flight status I have initiated program-wide activities to fully implement Admiral Truly's actions. Specifically, Space Shuttle managers at the Johnson Space Center, the Marshall Space Flight Center, and the Kennedy Space Center have been assigned responsibility for each specific action. These activities are well underway including the development of comprehensive implementation plans and schedules. Each activity includes appropriate participation from Space Shuttle project elements, from JSC, MSFC, and KSC engineering organizations, from the JSC flight crew (astronaut) operations organization, and from the Vandenberg launch and landing operations organization. Specific lead assignments and current status are summarized as follows:

1. The Solid Rocket Motor (SRM) Redesign Team is headed by Mr. John Thomas of the Marshall Space Flight Center. He has established a team in residence at MSFC that consists of approximately 75 people from both NASA and industry. Their preliminary work to date has concentrated on

the analysis of a wide range of proposed design fixes. The preliminary analyses support a potential delivery of redesigned and tested SRM flight segments to KSC in the March-April 1987 time frame.

2. A Space Shuttle Design Requirements Review Team headed by Mr. Jesse Goree of the NSTS Systems Integration Office at JSC has been assigned to re-review all NSTS design requirements and associated technical verification. The team will focus on each Shuttle project element and on total Space Shuttle system design requirements. This activity will culminate in a Space Shuttle Delta Design Certification Review (ΔDCR) approximately 3 months prior to the next Space Shuttle launch.

3. A complete re-review of all Space Shuttle program failure modes and effects analyses (FMEA's) and associated critical item lists (CIL's) was initiated shortly after the STS 51-L accident. Mr. Bill McCarty, NSTS Manager for Safety, Reliability, and Quality Assurance at the Johnson Space Center, has been assigned to lead this activity. Each Space Shuttle project element and their prime contractors are conducting separate comprehensive reviews which will culminate in a program-wide review with the NSTS Manager late this year. Technical specialists from outside the Space Shuttle program have been assigned as formal members of each of these review teams. As these reviews commence, all prior criticality 1 and 1R critical item waivers have been voided and the teams are required to reassess and formally resubmit for approval waivers in these categories recommended for continued program applicability. This activity will culminate in a comprehensive final review with Admiral Truly.

4. A program-wide re-review of all Space Shuttle test and checkout Operations and Maintenance Requirements and Specifications (OMRSD) is being conducted under the leadership of Mr. William Fischer of the NSTS Systems Integration Office at JSC. Particular emphasis will be placed on identifying and scrutinizing test requirements that deal with criticality 1, 1R, and 2 hardware. This activity is scheduled to be completed late in 1986 and is closely coupled with the FMEA/CIL and Operations and Maintenance Instruction (OMI) reviews.

5. A comprehensive review of Space Shuttle Operations and Maintenance Instructions (OMI's) is underway under the leadership of Mr. Robert Sieck, Director of Shuttle Management and Operations at KSC. The activity includes a full technical re-review of all Shuttle processing paper and requirements. In addition, it is responsible for developing closed-loop controls between FMEA/CIL, OMPSD, and OMI checkout requirements and procedures. This activity is expected to extend into the early 1987 time frame.

6. A Launch/Abort Reassessment Team has been established under Mr. Jay Greene, Flight Director at JSC. This team is re-reviewing Space Shuttle Launch Commit Criteria, Flight Rules, operational crew flight procedures, Space Shuttle ascent design, landing site selection and characteristics for aborts and nominal end-of-mission landing, and the design and requirements for the Space Shuttle Range Safety System and associated procedures. Ground rules and constraints associated with first flight are receiving high priority. Longer range items such as

final launch commit criteria, flight rules, and operations procedures will continue to be assessed right up to the first launch Flight Readiness Review (FRR).

7. Teams have been established to coordinate program-wide assessments, analysis, and planning necessary to define the schedule and characteristics for the Space Shuttle first flight and to develop projected first year and sustainable long-term Shuttle flight rates. The first flight definition team is headed by Mr. Edwin Hoskins, Head of the Flight Integration Office at JSC, and the flight rate team is headed by Mr. Alfred Bishop, Deputy Manager of the Mission Integration Office at JSC. The highest priority activity in this area has been the development of ground rules and constraints for first flight and determination of the first cargo. As a result of this work the program has recommended a first flight date of July 15, 1987, with a Tracking and Data Relay Satellite (TDRS) as the first cargo. Also, several manifest options for the first year of flight have been developed and proposed to the Associate Administrator for Space Flight. First year and sustainable flight rate assessments are discussed in a subsequent paragraph.

The above efforts will require a significant amount of manpower both within NASA and at their contractors. An interactive schedule which shows specific milestones and the detailed interrelationship of these activities is being developed. It is anticipated that this work will generally extend over the next 12 months and will culminate in special reviews to Admiral Truly at NASA Headquarters.

In addition to the reviews outlined above in direct response to Admiral Truly's strategy and actions for returning the Space Shuttle to flight status there are a number of additional program activities underway which I would like to briefly describe.

Shortly after the Challenger accident I felt that it was necessary to constitute a series of formal reviews to reassess areas of known technical risk across the Space Shuttle program elements. In this regard, I initiated a series of senior management special Program Requirements Control Board (PRCB) meetings in March to consider Shuttle system areas where safety margins are of concern. This board is chaired by the NSTS Manager and membership includes the project managers for all NSTS program elements and their contractor counterparts, the Johnson Space Center's Directors of Space Operations and Research and Engineering, and the Head of the Astronaut Office. To date, 96 different potential safety concerns involving Orbiter, external tank, and Space Shuttle main engine hardware and software have been considered. Of these, 44 are of a level of significance that improved hardware, software, processing, and/or operations may be required before resuming flight activities. Forward action paths are underway on each of these items and appropriate actions have been assigned. Technical improvements deemed not critical to first flight are also being aggressively pursued as potential downstream enhancements to Shuttle safety performance and operations. Board meetings to consider safety concerns involving Kennedy Space Center launch facilities will be conducted in the near future. Solid rocket booster safety concerns are being separately addressed by the Solid Rocket Motor Redesign Team at the Marshall Space Flight Center.

In association with other analyses of the STS 51-L accident, a special review of Space Shuttle crew egress/escape provisions has been initiated under Mr. Allen Louviere of the JSC Research and Engineering Directorate. The scope of this analysis will cover the total mission flight profile which includes on-pad, launch, ascent flight to orbit, and descent from orbit to landing phases. To analyze each aspect of the mission, design teams for ground egress, bail-out, ejection systems, water landing, and powered flight separation have been established. A system engineering team is in place to maintain study continuity and integrate the results of the proposed systems concepts studies. In conjunction with the system engineering team an envelope definition team will construct and provide the appropriate trajectories to be used across the total review. These trajectories will be overlaid with the physiological envelope limits and combined trajectory and physiological envelopes will be evaluated against the capabilities of the various survival system concepts. Initial team activities are in progress, with a preliminary report scheduled for June 15, 1986. From these data and preliminary analysis, it is expected that the most feasible concepts to be studied further will be selected. This study will consider modifications to the existing STS and concepts which may be included in future Space Shuttle vehicles.

In conjunction with all program elements, the NSTS Office has been developing a proposed plan for NSTS activites leading to the first Shuttle flight and a series of options for the manifest for the first few flights downstream. This plan includes provisions for major program objectives such as bringing the Vandenberg Launch Site (VLS) facilities and the Shuttle/Centaur upper stage into flight status, including any associated modifications to the Orbiter fleet. Both the VLS and Centaur activites are addressed in separate parts of this statement.

The basis for the plan is a schedule for the redesign and test of the solid rocket booster which could permit flight hardware delivery in support of a July 1987 initial launch. The cargo planned for this flight is a Tracking and Data Relay Satellite as a top agency priority.

The primary objective of the initial manifest for subsequent flights has been to select an early flight program that is conservative and relatively insensitive to schedule delays which might occur in either the SRB redesign, the Vandenberg launch site activation, or the Centaur modification programs such that all STS planning and training can be stabilized in this critical period. Thus, should a slip in any of these activities occur, the program could retain the same basic flight content and sequence with only a relatively simple adjustment of launch dates.

A key element of the options considered is that because of launch performance requirements many of the early high priority cargoes require either the Discovery or Atlantis Orbiter vehicles. Discovery is the only Orbiter fully instrumented and configured for the first Vandenberg launch. Therefore, the timing of any Vandenberg activity can be influenced by the priority of high performance requirements at KSC and vice versa. The basic options which result from these considerations relate to whether to retain a planetary flight on Centaur in December 1987, or to defer it in favor of other high priority TDPS, Space Telescope, or DOD missions. This decision will be influenced by overall decisions and implementation schedules on the Centaur project. The decision is also dependent upon confidence in the Vandenberg

Launch Site (VLS) activation activities. These factors are currently under consideration by NASA and DOD management, and it is expected that firm early manifest decisions will be committed in the near future.

At the time of the STS 51-L accident, STS Centaur hardware was well into its test program and resulting design issues were to be reviewed at a second design certification review scheduled for the February 1986 time frame. Subsequent to the accident, JSC and the Lewis Research Center initiated a comprehensive review of the Centaur vehicle and associated missions and defined a series of modifications which should be made to enhance Centaur safety. In addition, a series of studies and reviews were implemented to ensure that currently defined systems, processes, and procedures are adequate to control the hazards associated with Centaur operations. These studies and reviews are scheduled to be completed in September 1986.

Design modifications associated with Centaur oxygen and hydrogen dump valves have the greatest schedule risk of those changes specified to date. Other activities which could lead to additional Centaur schedule risks, should new concerns be uncovered, are a comprehensive review of the Centaur propellant tank pressure control system design and a review of system designs and procedures associated with safe control of the abort situation when the Shuttle must return with the tanked Centaur in the Orbiter cargo bay.

When currently defined modifications to Centaur and to the Orbiter are successfully completed, and when any further issues resulting from these continuing reviews are properly dispositioned, all known steps necessary to cause the Shuttle/Centaur to be as safe as possible will have been taken. However, the basic design of the Centaur, i.e., pressure-stabilized liquid oxygen and liquid hydrogen tanks with a common bulkhead will not permit total elimination of all risk.

A reassessment of the residual risk of Shuttle/Centaur operations and associated acceptability is currently underway and results will be presented to the Associate Administrator in the near future. Previous assessments of this risk have led to the conclusion that, given successful completion of program activities, the residual risk will be sufficiently controlled to certify the Centaur for flight. A significant consideration in the current reassessment will be the ability to maintain quality, reliability, and expertise in the Centaur program and to assure that the residual risks can be adequately controlled over a long period of operation.

Planning is continuing for the Vandenberg Launch Site (VLS) activites required to conduct special tests of the Shuttle vehicle and ground facilities late this year. These tests include vehicle and launch mount structural characteristics definition, Shuttle to facility interface verification, and a demonstration of liquid oxygen and liquid hydrogen tanking. The test plans are being structured to provide early verification of Vandenberg activation and, therefore, provide maximum time for any related problem resolution so as to minimize subsequent requirements for the first Vandenberg launch flow. To complete these early tests, the program plans to ship Columbia to Vandenberg in September 1986. Subsequent facility tests with Columbia will be conducted utilizing currently available filament wound case solid rocket booster hardware which will have to be substituted for a modified design prior to first flight.

A major potential issue associated with the Vandenberg launch pad design was identified prior to the Design Certification Review in November 1985. This concern relates to the ability to assure that there is no possibility of developing hazardous concentrations of gaseous hydrogen in the Space Shuttle main engine exhaust duct during Flight Readiness Firing (FRF) or launch/launch abort operations. This design issue requires resolution prior to FRF and first flight. The Department of Defense and NASA have been studying options for facility design changes to control this potential hazard and analyses and test plans to select and implement a solution are in progress. This activity together with the efforts required to redesign and certify the filament wound case solid rocket booster represent the major schedule issues related to the first Vandenberg flight.

With respect to the Space Shuttle Orbiters, a plan was put in place in mid-March to begin a concerted Orbiter modification effort to incorporate all outstanding vehicle modification kits at KSC which had not previously been scheduled for work. These kits represent approved modifications which had been designated "targets-of-opportunity" until a specific mission or manifest dictated their incorporation and non-mandatory work that had been deferred from prior launch preparation flows. The major categories of modification work are: wing structure beef-up to improve launch probability; thermal protection system upgrades to facilitate more efficient turnaround; fluid, mechanical, and structural modifications to accommodate the Centaur payload; and other unique instrumentation, communications, and payload accommodation changes. Columbia (OV-102) has 110 modifications scheduled. Discovery (OV-103) and Atlantis (OV-104) have 48 and 31 modifications respectively, which represent a lesser quantity primarily because these Orbiters were built later than Columbia and incorporated some features which Columbia requires as part of their initial build. The work is progressing as planned and will support a mid-1987 resumption of flights. Also, planning is underway to support any additional modifications dictated by the on-going Space Shuttle and Centaur safety reviews.

The NSTS Office has provided the results of an analysis of NSTS safe flight rate capability to the Associate Administrator for Space Flight. Based upon a review of the flight rate capacity of all NSTS elements, it was concluded that the limiting factor in determining flight rate is the amount of time required for turnaround and processing of vehicles and cargo at KSC. The recent best average turnaround achieved by the STS at KSC (i.e., the last six flights prior to STS 51-L), suggest that the program could achieve an operational flight rate of 12-15 flights per year with three Orbiters. This range is dependent upon subsequent program decisions regarding increased postflight inspection periods and manifest decisions. Manifest decisions, including the selection of specific cargoes and the number of Vandenberg launches, are very significant factors in determining actual flight rate accomplishment. The specific selection of cargoes has a flight rate effect because some cargoes such as Centaur, Spacelab, and certain DOD payloads require more integration and test time and, therefore, occupy the vehicles and facilities for periods longer than the norm. The net result of this effect is the suppression of the ideal flight rate capability which would be achievable for a manifest consisting primarily of commercial satellites and smaller science payloads. For Vandenberg Air Force Base (VAFB) flights, the extended launch pad operations and the fact that the Orbiter is currently planned to be processed at KSC, causes an Orbiter to be unavailable for

other flight operations for a longer period of time, thereby, also suppressing overall achieved flight rate. Therefore, a manifest which includes both VAFB and Centaur flights would result in the lower number of flights accomplished in that particular year.

This flight rate study also addressed the question of initial buildup to the operational flight rate once the Space Shuttle resumes flight operations. Factors which influence this buildup, in addition to the previously mentioned manifest decisions, are the increased turnaround time necessary for early-on detailed postflight inspection of SRB hardware and a conservative approach to returning to Orbiter checkout and processing times which are believed to be eventually achievable. Based upon these factors, the NSTS Office has recommended a flight rate buildup of 6-7 flights in the first year, 9-11 flights in the second year, and 12-15 flights in the third year. In each case a range has been specified to accommodate subsequent manifest decisions. A final conclusion of the study was that a fourth Orbiter would be required to sustain a realistic flight rate above the 12-15 flights per year range.

Finally, in consideration of the number, complexity, and interrelationships between the many activities leading to the next flight, I have initiated a series of formal Program Management Reviews for the National Space Transportation System program. These reviews are structured to be regular face-to-face discussions involving the managers of all major Space Shuttle program activities, and will be chaired by the NSTS Manager. Specific subjects to be discussed at each meeting will focus on progress, schedules, and actions associated with each of the major program review activities and will be tailored directly to current program activity for the time period involved. The first of these meetings was held at MSFC on May 5-6, 1986, and it proved to be a very effective session. Follow-on reviews will be held approximately every 6 weeks with the next meeting tentatively set for the week of June 16 at KSC.

Mr. Chairman, this concludes my prepared testimony. I appreciate this opportunity to appear before you today and would be pleased to answer any questions you may have.

Biographical Data

NASA National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

NAME: Arnold D. Aldrich

TITLE: Manager, National Space Transportation System

BIRTHPLACE AND DATE: Lexington, Massachusetts; July 7, 1936.

EDUCATION: Bachelor of science degree in electrical engineering, Northeastern University, 1959.

RESIDENCE: Seabrook, Texas.

MARITAL STATUS: Married to the former Eleanor Jean Harris of Boothbay Harbor, Maine.

CHILDREN: Susan Elizabeth, August 20, 1962; Russell Harris, March 10, 1965.

SPECIAL HONORS AND AWARDS: Presidential Rank of Meritorious Executive, 1982; NASA Distinguished Service Medal, 1981; and JSC Special Achievement Award, 1977; Arthur S. Fleming Award, 1976; NASA Outstanding Leadership Medal, 1975; JSC Certificate of Commendation, 1974; NASA Exceptional Service Medal, 1971; and MSC Certificate of Commendation, 1969 and 1970.

PROFESSIONAL AND HONORARY SOCIETIES: Fellow, American Astronautical Society, 1982; associate fellow, American Institute of Aeronautics and Astronautics; Eta Kappa Nu, National Electrical Engineering Honor Society; and JSC National Management Association.

EXPERIENCE:

1985-Present NASA Johnson Space Center, Houston, Texas. Manager, National Space Transportation System (NSTS). Lead Center Manager for the Space Transportation System (STS) program activities at the Johnson Space Center, the Marshall Space Flight Center, and the Kennedy Space Center for NSTS and overall systems management, integration, and operation of the Space Shuttle system. Provided Level II management of the program; directing and controlling scheduling and planning for NSTS design, development, test, production, and operations; integrating all elements of the program into a single operational system; ensuring effective cost control of the total program; establishing and controlling system and program requirements and

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Arnold D. Aldrich

EXPERIENCE (continued)

configuration; and directing overall management of the JSC Space Shuttle Orbiter and associated Government-furnished equipment projects.

1983-1985 Manager, Space Shuttle Projects Office. Responsible for program management of all hardware and software for the Orbiter spacecraft element of the NSTS. Technical and contract management activities for Orbiter systems development; Orbiter production and modifications; Orbiter ground support equipment; Orbiter avionics software development and reconfiguration control; Orbiter flight crew equipment; and engineering and logistics support for Orbiter operations. Overall flight readiness of the Orbiter spacecraft and related equipment to the Manager of NSTS for all STS missions.

1982-1983 Manager, Orbiter Project. Directed the design, development, production, and test of the Space Shuttle Orbiter. Maintained technical and financial cognizance of the Orbiter development and processing to assure its successful support to STS. Assured the Space Shuttle Program Manager of the overall flight readiness of the Orbiter.

1980-1982 Deputy Manager, Space Shuttle Program. Shared comprehensive management with the Program Manager. Established and controlled Space Shuttle detailed requirements and configuration; implementation of appropriate facilities for launch, flight, and landing support; flight planning and operations; detailed Program planning and scheduling for the Space Shuttle system and ensuring effective cost control across the total Program. The Program Manager provided technical and programmatic support to the Associate Administrator for STS.

1976-1980 Manager, Orbiter Avionics Systems Office, Orbiter Project Office. Overall project management of the development of the Space Shuttle Orbiter avionics system for the Orbital Flight Test program and for the Approach and Landing Test program. Chairman of the Orbiter Avionics Software Control Board which baselined and controlled all Space Shuttle Orbiter flight software requirements.

1975-1976 Manager, Program Assessment Office, Space Shuttle Program Office. Directed the performance of independent assessments of Space Shuttle Program technical and programmatic areas of particular criticality with special emphasis on flight vehicle systems engineering.

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Arnold D. Aldrich

EXPERIENCE (continued)

1973-1975 Deputy Manager, Apollo Spacecraft Program Office. Shared with the Program Manager planning and directing all aspects of the Command and Service Module (CSM) programs for the Skylab Program and the Apollo-Soyuz Test Project (ASTP). Participated directly in the negotiations with representatives of the USSR with respect to integrated systems design assessments, hardware development, and flight operations planning in carrying out the ASTP. In addition to his duties as Deputy Manager, he was assigned as Manager, Skylab Program. Responsible for equipment disposition, configuration control of residual hardware, contract closeout, and coordination of various activities related to exploitation of the Skylab experience and scientific data.

1972-1973 Deputy Manager, Skylab Program. Shared with the Program Manager overall planning, technical direction, and coordination of all aspects of the Skylab Program at JSC.

1966-1972 Chief, CSM Systems Branch, Flight Control Division. Flight operations activities in support of the CSM spacecraft during manned and unmanned Apollo flights. In 1972, assumed systems analysis and flight operations planning and preparation responsibilities for the various spacecraft elements of the Skylab Program. In preparing for Skylab, he directed activities which led to the evolution of flight systems management and data handling approaches which were keyed to the long-duration Earth orbital nature of the Skylab missions.

1961-1966 NASA Manned Spacecraft Center, Houston, Texas. Head, Gemini Systems Section, Flight Control Division. All flight control activities relating to performance, malfunction analysis, and ground control of the Gemini spacecraft systems. Operated key console positions in the Mission Control Center.

1959-1961 NASA Space Task Group (forerunner of NASA Manned Spacecraft Center), Langley Field, Virginia. During the initial phases of Project Mercury, contributed significantly to initial manned spacecraft flight operations philosophies, techniques, and procedural planning.

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JANUARY 1986

Mr. NELSON. Thank you, Mr. Aldrich.

Mr. Young.

Mr. YOUNG. Mr. Chairman and distinguished members of the subcommittee, we'd like to tell you a little bit about the Astronaut Office participation to aid in the recovery from the 51-L *Challenger* accident.

As you probably know, we have astronauts assigned to cover every activity associated with the accident. We're included in the Presidential Commission investigation of the accident, at NASA Headquarters in the Accident Action Center, and on every panel of the Data and Design Task Force, and Captain Crippen is a key member of that task force. He wouldn't tell me what his real job is, but he said he was chief gopher.

Astronauts are working right now in specific reviews in the space shuttle critical items lists and the failure modes and effects analysis at all the space shuttle centers, at Johnson, at Marshall, and at Kennedy. We expect that the review of these lists and these failure effects analyses will find items that need additional consideration with respect to safety design and/or test and checkout.

We believe we'll need additional effort downstream in the space shuttle turnaround to assure that the life cycle reliability of critical elements and subsystems in the Space Shuttle Program are maintained over the life of the program.

In addition, other astronauts in our operating development working group are working full-time on the present activity to participate in the launch and the launch abort reassessment panels. They're participating in the first space shuttle flight design and the first year of shuttle activity tasks.

Every space shuttle system and every operating mode has an astronaut assigned to cover it now that we're not flying. They participate in meetings at every NASA center on the orbiter and the Program Requirements System Design Review Control Boards, and, as you heard Arnie say, the Space Operations Directorate just brought a number of safety design changes to that Board that he chairs.

We believe the majority of those changes will fall into the fix-before-flight category or fix-in-the-near-term Category—which we assign to the completion of the carbon brakes, which is scheduled for mid-1988. I don't know where the money comes from to fix those things, but I feel so strongly and so do the members of the Astronaut Office that they ought to be fixed. If extra money is required, it ought to come from the other space programs. Because, let's face it, if we don't have a space shuttle, we don't need to talk about the space station much. And, if we're going to have safe shuttle operations, we're going to need to make some of these changes.

Our own activity in the Astronaut Office has been restructured, including our safety programs. Now that we're in the standdown, we plan to pursue a more conservative design, planning, procedure, and operation to reduce flight risks. That's the ideas that we intend to advance.

To support those safety proposals, we have assigned a senior astronaut to handle our safety in the Astronaut Office, Henry Hartsfield. At the present time, he is assisted by many other astronauts

responsible for the orbiter, for the orbiter's payloads, and the critical items list, and the failure mode and effects analysis, and other safety reviews that we're conducting.

We still believe, from a nuts and bolts standpoint, that the agency needs a pervasive safety group associated with overall space shuttle accident correction and future operations. The reason for this is, down at the working levels—and when I say pervasive, down at the working levels, you find out things in some of these working levels that really should be elevated long before somebody has to go to a change control board.

It's not clear from where we sit in these boards, and panels, and meetings that go on all over NASA that that line of communications is as good as it ought to be in order to make sure that we don't have another accident. We trust that senior management is attuned to these concerns, and we know that they believe, as we do, that this is all going to be corrected before we fly again.

In the interim, since we are participating in meetings, and panels, and review boards all over the centers, when we find a safety problem, we kick it upstairs.

We have crews also assigned to working in integration simulations with the mission control center still doing things on new procedures and working with such new missions as the *Centaur* payload and the Vandenberg high inclination western test range flights, which Captain Crippen is going to be in charge of that mission.

In summary, we have astronauts supporting to the best of our ability those actions that we perceive in the best interests of our Nation to return the space shuttle to safe operating status.

Thank you.

[The prepared statements of Robert Crippen, Paul Weitz, and John Young follow:]

NASA
National Aeronautics and Space Administration

Hold for Release Until
Presented by Witness

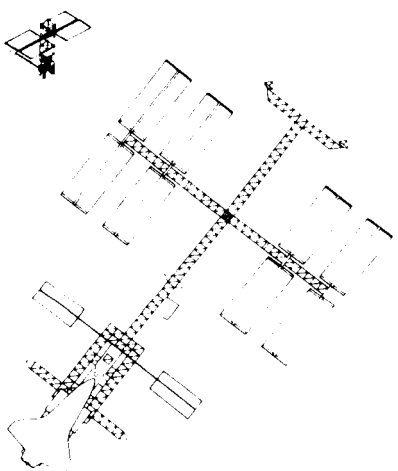
May 15, 1986

Subcommittee on Space Science and Applications
Committee on Science and Technology

House of Representatives

Statement by:

Robert L. Crippen
Paul J. Weitz
John W. Young



99th Congress

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Statement of

MAY 15, 1986

Robert L. Crippen
Paul J. Weitz
John W. Young

National Aeronautics and Space Administration

before the
Subcommittee on Space Science and Applications
Committee on Science and Technology
United States House of Representatives

Mr. Chairman and Distinguished Members of the Subcommittee:

We want to tell you about Astronaut Office participation to aid in the recovery from the 51-L Challenger accident.

We have astronauts assigned to cover every activity associated with the Challenger accident. Astronauts are included in the Presidential Commission investigation of the accident, at NASA Headquarters in the Accident Action Center and on every panel of the Data and Design Task Force.

Astronauts are working right now in the the specific reviews of the Space Shuttle critical items lists with safety, reliability and quality assurance people. We expect that the review of these lists will discover items that need additional consideration with respect to design change and/or test and checkout. We believe that we need additional effort in Space Shuttle turnaround to insure the life cycle reliability of critical elements and subsystems in the Space Shuttle Program.

Astronauts are also participating in the solid rocket motor redesign both on the working teams and the oversight team.

In addition, astronauts are working full time on the present activity of the launch/launch abort reassessment panels, first Space Shuttle flight design, and first year of Shuttle activity tasks.

All Space Shuttle systems and operational modes have astronauts covering them. These astronauts participate in meetings of the Orbiter and Program Requirements System Design Review Change Control Boards. For example, the Space Operations Directorate brought forward to these boards a number of safety-critical design changes which are being dispositioned by appropriate change boards. The majority of these changes will undoubtedly fall into the fix-by-first-flight or the fix-in-the-near-term (mid-1988) categories. We sincerely believe that it will be in the best overall interests of the Nation -- if we are going to have safe Shuttle operations -- to make these safety-critical changes.

In the Astronaut Office, our own safety program has been restructured. During our standdown from Space Shuttle flights, our safety policy is to reduce Space Shuttle flight risk wherever practical. If more conservative design, planning, procedures, or operations can reduce flight risk, then

we intend to advance those concepts. To support our safety proposals, the Astronaut Office Safety Officer is a most important job for a senior astronaut. At the present time, he is assisted by other astronauts responsible for the Orbiter and its payloads, the critical items list, and safety review astronaut leaders.

We still believe the Agency needs a pervasive safety group concerned with overall Space Shuttle accident correction and future operations. There is evidence that the lines of communication are not as good as they must be with respect to safety issues. It is not clear from where we sit in the boards, panels, and meetings all over NASA that safety problems are reaching proper management levels in order to insure their early correction, but we trust that senior management is attuned to these problems and recognize that they must be solved before we fly again. In the interim, while we have no strong agency-wide safety group, we have been taking action to investigate and notify people about potential safety problems when we discover them on our own.

We also have crews assigned to missions working in integration simulations with mission operations people on new procedures and proposed missions for the future such as the Centaur payload and the Vandenberg high inclination Western Test Range flights.

In summary, astronauts have been supporting to the best of our ability those actions that we perceive to be in the best interests of our Nation to return the Space Shuttle to safe operating status.

Biographical Data

NASA

National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

NAME: Robert L. Crippen (Captain, USN)
NASA Astronaut

BIRTHPLACE AND DATE: Born in Beaumont, Texas, on September 11, 1937

PHYSICAL DESCRIPTION: Brown hair, brown eyes, height, 5 feet 10 inches, weight 160 pounds.

EDUCATION: Graduated from New Caney High School in Caney, Texas, received a bachelor of science degree in Aerospace Engineering from the University of Texas in 1960.

MARITAL STATUS: Single

CHILDREN: Ellen Marie, June 14, 1962, Susan Lynn, December 24, 1964, Linda Ruth, May 10, 1967.

ORGANIZATIONS: Member, Society of Experimental Test Pilots, associate fellow, American Institute of Aeronautics and Astronautics, and fellow, American Astronautical Society.

SPECIAL HONORS: Awarded the NASA Distingushed Service Medal (1981), the NASA Exceptional Service Medal and the JSC Group Achievement Award (1972), the Department of Defense Distinguished Service Award (1981). Also received the American Astronautical Society Flight Achievement Award (1981), the National Geographic Society's Gardiner Greene Hubbard Medal (1981), the Aviation Hall of Fame 1981 Al J. Engel Award, the American Legion's Distinguished Service Medal (1981), the SETP Ivan C. Kincheloe Award (1981), the Federal Aviation Administration's Award for Distinguished Service (1982), the Goddard Memorial Trophy (1982), the Harmon Trophy (1982), and four NASA Space Flight Medals

EXPERIENCE: Crippen received his commission through the Navy's Aviation Officer Program at Pensacola, Florida, which he entered after graduation from the University of Texas. He continued his flight training at Whiting Field, Florida, and went from there to Chase Field in Beeville, Texas, where he received his wings

From June 1962 to November 1964, he was assigned to Fleet Squadron VA-72 -- completing 2½ years of duty as an attack pilot aboard the aircraft carrier USS INDEPENDENCE. He later attended the USAF Aerospace Research Pilot School at Edwards Air Force Base, California, and upon graduation, remained there as an instructor until his selection in October 1966 to the USAF Manned Orbiting Laboratory Program. Crippen was among the second group of aerospace research pilots to be assigned to the MOL program.

He has logged more than 6,000 hour flying time, which includes more than 5,500 hours in jet aircraft.

NASA EXPERIENCE: Crippen became a NASA astronaut in September 1969. He was a crewmember on the highly successful Skylab Medical Experiments Altitude Test (SMEAT) -- a 56-day simulation of the Skylab mission, enabling crewmen to collect medical experiments baseline data and evaluate equipment, operations, and procedures.

Crippen was a member of the astronaut support crew for the Skylab 2, 3, and 4 missions, and he served in this same capacity for the Apollo-Soyuz Test Project (ASTP) mission, which was completed successfully in July 1975.

Crippen completed his first space flight as pilot of STS-1, the first orbital test flight of the Shuttle Columbia, April 12-14, 1981. He was accompanied by John Young (spacecraft commander) on this 54-½ hour, 36-orbit engineering test flight to evaluate and verify Shuttle systems performance during launch, on-orbit, and landing operations. STS-1 achieved a nominal 146 nautical mile circular orbit. Tests included evaluation of Orbiter hardware and software systems, investigation of the Orbiter thermal response while in orbit, evaluation of Orbiter attitude and maneuvering thruster systems and guidance navigation system performance, and evaluation of Orbiter crew compatibility. Columbia was the first true manned spaceship. It was also the first manned vehicle to be flown into orbit without benefit of previous unmanned "orbital" testing; the first to launch with wings using solid rocket boosters. It was also the first winged reentry vehicle to return to a conventional runway landing, weighing more than 99-tons as it was braked to a stop on the dry lakebed at Edwards Air Force Base, California.

Crippen was next spacecraft commander of STS-7, the second flight for the Orbiter Challenger, June 18-24, 1983. This was the first mission with a 5-person crew which included Rick Hauck (pilot), and mission specialists, John Fabian, Sally Ride, and Norman Thagard. During the mission, the crew deployed satellites for Canada (ANIK C-2) and Indonesia (PALAPA B-1); operated the Canadian-built Remote Manipulator System (RMS) to perform the first deployment and retrieval exercise with the Shuttle Pallet Satellite (SPAS-01); conducted the first formation flying of the orbiter with a free-flying satellite (SPAS-01); carried and operated the first U.S./German cooperative materials science payload (OSTA-2); and operated the Continuous Flow Electrophoresis System (CFES) and the Monodisperse Latex Reactor (MLR) experiments, in addition to activating seven Getaway Specials. Mission duration was 147 hours before landing at Edwards Air Force Base, California.

On his third flight, Crippen was spacecraft commander of STS 41-C, April 6-13, 1984. His crew included Dick Scobee (pilot), and mission specialists, Terry Hart, Pinky Nelson, and Ox van Hoften. During this 7-day mission the crew successfully deployed the Long Duration Exposure Facility (LDEF); retrieved the ailing Solar Maximum Satellite, repaired it on-board the orbiting Challenger, and replaced it in orbit using the robot arm called the Remote Manipulator System (RMS); flight tested the Manned Maneuvering Units (MMU's) in two extravehicular activities (EVA's); as well as operating the Cinema 360 and IMAX Camera Systems, and a Bee Hive Honeycomb Structures student experiment. Mission duration was 168-hours before landing at Edwards Air Force Base, California.

As spacecraft commander of STS 41-G, October 5-13, 1984, Crippen's crew, the largest to fly to date, included Jon McBride (pilot), three mission specialists, Kathy Sullivan, Sally Ride and Dave Leestma, as well as two payload specialists, Marc Garneau and Paul Scully-Power. Their 8-day mission deployed the Earth Radiation Budget Satellite, conducted scientific observations of the earth with the OSTA-3 pallet and Large Format Camera, as well as demonstrating potential satellite refuelling with an EVA and associated hydrazine transfer. Mission duration was 197 hours and concluded with a landing at Kennedy Space Center, Florida.

CURRENT ASSIGNMENT: Captain Crippen is currently assigned as spacecraft commander of STS 62-A, which is scheduled for launch in mid 1986. This will be the first Space Shuttle launched from Vandenberg Air Force Base, California.

JANUARY 1986

Biographical Data

NASA

National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

NAME: John W. Young (Mr.)
NASA Astronaut

BIRTHPLACE AND DATE: Born in San Francisco, California, on September 24, 1930.

PHYSICAL DESCRIPTION: *Brown hair, green eyes, height: 5 feet 9 inches; weight: 165 pounds.*

EDUCATION: Graduated from Orlando High School, Orlando, Florida, received a bachelor of science degree in Aeronautical Engineering with highest honors from the Georgia Institute of Technology in 1952.

MARITAL STATUS: Married to the former Susy Feldman of St. Louis, Missouri.

CHILDREN: Daughter, Sandy, April 30, 1957. Son, John, January 17, 1959.

RECREATIONAL INTERESTS: Running

ORGANIZATIONS: Fellow of the American Astronautical Society (AAS), the Society of Experimental Test Pilots (SETP), and the American Institute of Aeronautics and Astronautics (AIAA).

SPECIAL HONORS: Awarded the Congressional Space Medal of Honor (1981), the Department of Defense Distinguished Service Medal (1981), 3 NASA Distinguished Service Medals, 2 NASA Exceptional Service Medals, Navy Astronaut Wings (1965), 2 Navy Distinguished Service Medals, 3 Navy Distinguished Flying Crosses, the Georgia Tech Distinguished Young Alumni Award (1965), Distinguished Service Alumni Award (1972), 2 SETP Ivan C. Kincheloe Awards (1972 and 1981), 3 AAS Flight Achievement Awards (1972, 1981 and 1983), 3 AIAA Haley Space Flight Awards (1973, 1982 and 1984), the ASME Spirit of St. Louis Medal (1983), the Brackley Pilots and Air Navigators Trophy from the United Kingdom, the Goddard, Collier and Harmon Trophies from the United States, the National Geographic Society Hubbard Medal (1982), more than 45 other major awards and 4 honorary doctorate degrees.

EXPERIENCE: Upon graduation from Georgia Tech, Young entered the United States Navy. After serving on the west coast destroyer, USS LAWS (DD-558), for 1 year, he was sent to flight training in props, jets, and helicopters. He was then assigned to Fighter Squadron 103 for 4 years, flying Cougars and Crusaders.

After test pilot training at the U.S. Navy Test Pilot School in 1959, he was assigned to the Naval Air Test Center for 3 years. His test projects included evaluations of the Crusader and Phantom fighter weapons systems. In 1962, he set world time-to-climb records to 3,000- and 25,000-meter altitudes in the Phantom. Prior to reporting to NASA, he was maintenance officer of Phantom Fighter Squadron 143. Young retired from the Navy as a Captain in September 1976, after completing almost 25 years of active military service.

He has logged more than 10,200 hours flying time, including 835 hours in six spaceflights.

NASA EXPERIENCE: In September 1962, Young was selected as an astronaut. He is the first person to fly in space six times. The first flight was with Gus Grissom in Gemini 3, the first manned Gemini mission, on March 23, 1965. This was a complete end-to-end test of the Gemini spacecraft. On Gemini 10, July 18-21, 1966, Young, as commander, and Mike Collins, as pilot, completed a dual rendezvous with two separate Agena target vehicles. Mike Collins also did an extravehicular transfer to retrieve a micrometeorite detector from the second Agena. On his third flight, May 18-26, 1969, Young was command module pilot of Apollo 10. Tom Stafford and Gene Cernan were also on this mission which orbited the Moon and completed

a lunar rendesvous. His fourth spaceflight, Apollo 16, April 16-27, 1972, was a lunar exploration mission, with Young as spacecraft commander, and Ken Mattingly and Charlie Duke. Young and Duke set up scientific equipment and explored the lunar highlands at Descartes. They collected almost 200 pounds of rocks and drove over 27 kilometers in the lunar rover while on the moon.

Young's fifth flight was as spacecraft commander of STS-1, the first flight of the Space Shuttle Columbia, April 12-14, 1981, with Bob Crippen as pilot. The 54-1/2 hour, 36 orbit mission verified Space Shuttle systems performance during launch, on orbit, and entry. Tests included evaluation of the orbit mechanical systems such as the payload bay doors; attitude and maneuvering rocket thrusters, guidance and navigation systems; and Orbiter/crew compatibility. Columbia is the first manned spaceship to be flown into orbit without benefit of previous unmanned orbital testing. Columbia is also the first winged reentry vehicle to return from space to a runway landing. It weighed almost 100 tons as Young braked it to a stop on the dry lakebed at Edwards Air Force Base, California.

Young's sixth flight was as spacecraft commander of STS-9, the first Spacelab mission, November 28-December 8, 1983, with pilot Brewster Shaw, mission specialists Bob Parker and Owen Garriott, and payload specialists Byron Lichtenberg of the USA, and Ulf Merbold of West Germany. The mission successfully completed all 94 of its flight test objectives. For 10 days the 6-man crew worked 12 hour shifts around-the-clock, performing more than 70 experiments in the fields of atmospheric physics, earth observations, space plasma physics, astronomy and solar physics, materials processing and life sciences. The mission returned more scientific and technical data than all the previous Apollo and Skylab missions put together. The Spacelab was brought back for reuse, making Columbia the heaviest Orbiter yet returned, at 111 tons, as Young landed the spaceship at Edwards Air Force Base, California.

Young was also on four backup crews - backup pilot in Gemini 6, backup command pilot of Apollo 7, and backup spacecraft commander for Apollo 13 and 17. In preparation for prime and backup crew positions on 10 spaceflights, Young has put more than 11,100 hours into training so far, mostly in simulations and simulators.

In January 1973 Young was assigned the Space Shuttle Branch of the Astronaut Office, providing operational and engineering astronaut support for the design and development of the Space Shuttle. In January 1974 he was made Acting Chief of the Astronaut Office, and, in January 1975, Chief of the Astronaut Office, with responsibility for the coordination, scheduling, and control of activities of more than 90 astronauts.

JANUARY 1985

Biographical Data

NASA

National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

NAME Paul J. Weitz (pronounced WHITES) (Mr.)
NASA Astronaut

BIRTHPLACE AND DATE Born in Erie, Pennsylvania, on July 25, 1932. His mother, Mrs. Violet Futrell, now resides in Norfolk, Virginia.

PHYSICAL DESCRIPTION Blond hair; blue eyes; height: 5 feet 10 inches; weight: 180 pounds.

EDUCATION Graduated from Harborcreek High School in Harborcreek, Pennsylvania; received a bachelor of science degree in Aeronautical Engineering from Pennsylvania State University in 1954 and a master's degree in Aeronautical Engineering from the U.S. Naval Postgraduate School in Monterey, California, in 1964.

MARITAL STATUS Married to the former Suzanne M. Berry of Harborcreek, Pennsylvania; her father is Mr. John H. Berry.

CHILDREN Matthew J., September 23, 1958; Cynthia A., September 25, 1961.

RECREATIONAL INTERESTS Hunting and fishing are among his hobbies.

ORGANIZATIONS Fellow, American Astronautical Association.

SPECIAL HONORS Awarded the NASA Distinguished Service Medal, the Navy Distinguished Service Medal, Astronaut Wings, Air Medal (5 awards), and Commendation Medal (for combat flights in Vietnam); the Los Angeles Chamber of Commerce Kitty Hawk Award (1973); the Robert J. Collier Trophy for 1973 (1974); the Pennsylvania State University Alumni Association's Distinguished Alumni Award; named a Pennsylvania State University Alumni Fellow (1974); the AIAA Haley Astronautics Award for 1974; the Federation Aeronautique Internationale's V. M. Komarov Diploma for 1973 (1974); the Dr. Robert H. Goddard Memorial Trophy for 1975; the 1974 Harmon International Aviation Trophy for Astronaut (1975); NASA Space Flight Medal (1983).

EXPERIENCE Weitz received his commission as an Ensign through the NROTC program at Pennsylvania State University. He served for one year at sea aboard a destroyer before going to flight training and was awarded his wings in September 1956. He served in various naval squadrons until he was selected as an astronaut in 1966. He has logged more than 6,800 hours flying time--5,500 hours in jet aircraft.

NASA EXPERIENCE Mr. Weitz is one of the 19 astronauts selected by NASA in April 1966. Weitz served as pilot on Skylab 2 (SL-2), the first manned Skylab mission, which launched on May 25 and ended on June 22, 1973. With him for the initial activation and 28-day flight of the Skylab orbital workshop were Charles Conrad, Jr., (spacecraft commander) and Joseph P. Kerwin (science pilot).

In logging 672 hours and 49 minutes aboard the workshop, the crew established what was then a new world record for a single mission. Weitz also logged 2 hours and 11 minutes in extravehicular activities.

Weitz was spacecraft commander of STS-6, which launched from Kennedy Space Center, Florida, on April 4, 1983. He was accompanied by Colonel Karol J. Bobko (pilot), and two mission specialists, Dr. F. Story Musgrave and Mr. Donald H. Peterson. During this maiden voyage of the spacecraft Challenger, the STS-6 crew conducted numerous experiments in materials processing, recorded lightning activities, deployed IUS/TDRS-A, and conducted spectacular extravehicular activity while testing

Getaway Specials Mission duration was 120 hours before landing Challenger on a concrete runway at Edwards Air Force Base, California, on April 9, 1983

With the completion of this flight Paul Weitz has now logged a total of 793 hours in space.

MARCH 1984

Mr. NELSON. Thank you, gentlemen.

Needless to say, a host of questions have arisen from your testimony and from members over the course of time.

The budget is being considered on the floor today, so we will be interrupted from time to time with some votes. We're mindful, Mr. Moore, of your need to depart for a 12:30 meeting, and we will certainly honor that, and we are going to have considerable participation by all the members of the committee today.

I'll start out with just a few questions and then proceed with our members. Then as time goes on, through the course of the hearing, we'll intersperse with other questions and then tie up some loose ends toward the end before we have our next panel.

As we approach the question of flight safety, part of the reason for calling this hearing today was to approach it from Admiral Truly's memo in looking to the future how we can get ourselves straightened out so that we have that confidence and assurance for the future.

Part of it, however, also was sparked by virtue of the memo that, Mr. Aldrich, you had written on January 14 while STS 61-C was on orbit, right after it had launched, discussing a number of things that you were concerned about, and a memo subsequently written by Mr. Young in which he had discussed a number of things of flight safety.

We don't want to necessarily dwell on that. The thrust of this is to look to the future as to how we correct and make sure that we have the assurance. Nevertheless, I need to look to those two particular instances with regard to STS 61-C.

Now, for example, both of you in your memos mention that had a scrub not occurred on January 7, which was a scrub that occurred by virtue of unacceptable weather conditions in Dakar, Senegal, and Moron, Spain, had we launched. I think both of you in your memos use words to the effect of, it could be potentially catastrophic to the vehicle and to the crew, and you noted that that was due to the fact that after the scrub and you detanked, you found this temperature probe from the ground support equipment had flowed through the lox line and stuck into a prevalve and stuck it open, and you described what the consequences would have been at main engine cutoff with that valve stuck open.

Let me turn to you, Mr. Aldrich. Would you elucidate and give us some ideas as to that particular incident and what we can do for the future as it applies to the overall ensuring of flight safety?

Mr. ALDRICH. Mr. Chairman, let me address that and try to describe that briefly but in a way that characterizes what went on there.

The space shuttle main engines are very complicated engines, and they have a lot of characteristics that we've worried about over the years. One of those characteristics is the shutdown sequence, and if it is not performed correctly with the two propellants, it can in fact detonate or explode rather than shut down correctly.

That was addressed in the mid-1970 timeframe, and the design feature for the shuttle system that was selected to allow for proper shutdown was utilizing prevalves in the orbiter aft end that are not part of the space shuttle main engine directly to cut off the liquid

oxygen supply ahead of the main engine shutdown so that you don't have what is called an oxidizer rig shutdown.

If that is properly achieved, the engine will shut down reliably and normally. If it's not achieved, it's very difficult in testing on the ground to prove conclusively that you could not have the kind of catastrophic risk that the chairman mentioned and that I referred to.

The problem that occurred with the vehicle in Florida on 61-C was after the detanking on January 7. We found a liquid oxygen temperature sensor probe from the ground support equipment lodged in this prevalve in the orbiter system, and in fact had that temperature sensor been lodged there and had we flown, it's quite likely the prevalve would not have closed correctly, would not have cut off the oxidizer supply correctly, and you would have had a much higher risk of an untoward occurrence at main engine shutdown.

Having found that situation, we addressed that particularly and uniquely at the time. We looked at the oxidizer and liquid hydrogen probes, temperature probes, in both those lines leading to the vehicle and found that we could remove the probes completely from the hydrogen side, and they were removed and capped so that there would be no future threat of a probe coming loose downstream of the screens in that system.

On the oxidizer sides, those probes are required for the loading sequence to be handled safely, and therefore they were removed and reinspected, and in fact the problematic probe that failed was found to have a deficient weld in its manufacture. The probes were inspected thoroughly and tested to be sure that all welds and all characteristics of those probes that were reinstalled were adequate. In fact, they were reinstalled, and we proceeded with the 61-C and subsequent operations with that configuration—that is, reverified probes in the oxygen system, probes missing in the hydrogen system.

For the downstream, as part of the re-review process, we have directed that final filters now be placed downstream of all elements in the oxidizer system. That was a prior design consideration in the system. However, there was a misunderstanding about whether these probes, which are made out of stainless steel, were structure or were active elements, and, rather than revisit that discussion, we are now planning to reinstall filters downstream of everything in both those hydrogen and oxygen lines.

Additionally, all other propellant servicing lines leading to the space shuttle vehicle are being reassessed for this particular kind of problem occurrence.

Mr. NELSON. Including the ground support equipment?

Mr. ALDRICH. Yes, sir. They are ground support equipment lines, and they will be addressed at the interface with the space shuttle to be sure there are no active components in critical lines that can break loose and not be trapped by a final filter.

Mr. NELSON. Is there any less reliability in the welds for such items such as this temperature probe in the ground support equipment as opposed to the welds that are within the lines on the orbiter?

Mr. ALDRICH. To my knowledge, there is not intended to be. We intend to procure and specify ground support equipment that interfaces with the flight vehicle to the same rigorous specs and certifications that the flight vehicle hardware sees. However, in this case we certainly had a fault that was found inadvertently.

Mr. NELSON. It was a faulty weld.

Mr. ALDRICH. Yes, sir.

Mr. NELSON. Now supposedly in your design, you have that arranged so that you've always got a filter or a screen that will catch something there, and what you're saying is you're redesigning that now so that you have those filters.

Mr. ALDRICH. Yes, sir.

Mr. NELSON. But you're not considering a filter that would go on the ground support equipment line before it ever comes into the orbiter?

Mr. ALDRICH. It would be the final component on the ground support line. It would not change the characteristic of the orbiter or the other elements of the shuttle vehicle. So it is a ground support equipment change, but it becomes a totally final element of the system.

Mr. NELSON. OK.

Mr. Young, as you look back on this, what do you think about—is this just part of a highly complicated machine that we learn about as we go about in adjusting our designs? What are your feelings about that?

Mr. YOUNG. Well, that particular thing is certainly a complex thing. If that failure would cause the engine to overspeed and fail catastrophically, I still think that somebody needs to look at running this zero G test, because there are things that—you want to make sure that valve is reliable. It has a lot of single point failures in it.

It's not only that valve, but it has to be serviced by the Pogo system, which is a totally different system with check valves in it; there are single points; and the main engine controller has to work. So you want to look at all these things. You want to run the proper test.

There's some data that says it might not be catastrophic. So if you run your proper test and find out it's not catastrophic, you don't have to fix anything and we've made a big fuss over nothing.

Mr. NELSON. All right. And you're saying there needs to be a zero G test.

Mr. YOUNG. If they can do it.

Mr. NELSON. Has it been done before?

Mr. YOUNG. We had it on the books many years ago, but we had to drop it because we didn't have enough money or something.

Mr. NELSON. OK. Would you pull that mike just a little bit closer.

Well, let's go to another example in which I think both of you have cited. It occurred the previous day, on January 6. Just before T minus 31 seconds and counting, one of the people in the launch control center noticed that a temperature red line had been exceeded as to the coolness of part of the lox lines, and a decision was made at that point to stop the count, which it stopped at 31 seconds.

Subsequently, it was determined that a mistake had been made in flipping a switch in which liquid oxygen started to drain out of the external tank, and therefore there was less oxygen; perhaps you all can supply the details; I think it was about 1,800 pounds that was drained out of the tank. That was discovered after the count had been stopped with 31 seconds left.

Why don't I turn to you, Mr. Young, and why don't you elucidate on that and what you think ought to be done about that for the future.

Mr. YOUNG. Well, there's a number of things when you have an incident like that happen to you, I think you need to stop and find out what really happened in real time before you proceed on further downstream, and that's not hard to do.

I'm glad that the Marshall Space Flight Center didn't relieve that temperature constraint, because you might not have had all the propellant you needed in the tank to get to orbit if you had launched, so that was a good thing there.

I think the safety committees that will be in process in the future, if something like that happens, we won't proceed as rapidly as we might, and we'll take a look and see what happened, just like you do in any other incident when you're operating with things that you don't understand. You've got to understand them before you go on further, and that's a reasonable thing to do.

Mr. NELSON. All right. So that the checks and balances were there. There was an alert fellow from Marshall and his contractor that noticed that temperature red line exceeding, and so that caught the system even though the mistake actually had been made that was not caught when the lox was accidentally being drained out of the tank.

Mr. YOUNG. That's very true, and the Kennedy people caught it also, and they stopped everything. But still and all, at the time it wasn't a well understood idea of what happened. But they did the right thing.

Mr. NELSON. Had we ever seen in all of the previous 24 launches—had we seen anything like that before, to your knowledge?

Mr. YOUNG. No, sir.

Mr. NELSON. To the knowledge of anybody—anybody on the panel?

Mr. MOORE. No, sir.

Mr. ALDRICH. No, sir.

Mr. NELSON. OK. How about the temperature probe sticking in the prevalve, sticking it open? Had we ever seen that before?

Mr. MOORE. No, sir.

Mr. ALDRICH. No, sir.

Mr. YOUNG. One of the things we are trying to do for the Kennedy people is to get them a better ability to be able to simulate a malfunction so that they can get some real time practice on these kinds of things. That's very difficult to do when you have something as complicated as the launch process, but they're working on that.

Mr. NELSON. As we talk about these things from my questions and the questions of other members, we might continuously refer

back to our whole history, as to whether or not it's something that occurred before or if it's one incident that occurred.

All right, now there was another situation that was not mentioned by either of you in your memos but has subsequently come out about the forward RCS system. One of the test requirements on STS 61-C was, as it reentered the atmosphere, the forward RCS jets were going to be fired, one on the left side and one on the right side simultaneously, and this was for a reason which was, if you ever had to do an abort landing such as in a TAL abort or an RTLS, you wanted to start trying to get rid of some of that fuel in the nose.

If I recall, about a day before the reentry, this test was canceled at the recommendation of Rockwell, and it was canceled on the basis that they thought it was too risky for the reason, as explained by the commander, Mr. Gibson, that if those jets did not fire precisely at the same time, one on the left and one on the right, you might have some action like that which could throw you out of your angle of attack coming down through the atmosphere.

Subsequent to that, it is my understanding that it was discovered that the RCS jets on that orbiter, *Columbia,* were of an older variety, not like the other three orbiters, that there was a potential that, although they were fine for use in the vacuum of orbit, that they may not have been fine for use as you came back through the atmosphere, and therefore a potential explosion.

Could any of you all address the accuracy or nonaccuracy of that statement, and what are its implications, and what are its implications for the future? Who would like to take that?

Mr. Aldrich.

Mr. ALDRICH. I'll take that, Mr. Chairman.

The test to determine the feasibility of dumping the propellant from the Ford RCS system during entry was one that the program elected to bring into the program early in 1984 for the purpose of causing the vehicle to be lighter for particularly abort landings, RTLS and trans-Atlantic landings, where the landing limit for the total vehicle and payload combination is 240,000 pounds, and for cargoes to be manifested later in this decade, we would regularly be required to deal with potentially exceeding that abort landing weight.

Analyses were initially done at the Johnson Space Center and at Rockwell that said that it was likely that Ford RCS propellant could be really burned through the engines rather than dumped as we already were doing with the aft RCS systems on the orbiter, and during 1985 wind tunnel tests were done at the Langley Research Center which confirmed aerodynamically that this should be acceptable.

So in the summer of 1985, the program moved forward with a multiflight plan to do tests during entry with what we call design test objectives—DTO's—in this regard, and it did require multiple firings of yaw RCS engines both sides simultaneously to test the characteristics of system performance and aerodynamic performance.

This was reviewed thoroughly and formally through the program through a process of reviewing DTO's that we use on all design test objectives and was thought by the technical community to be sound

and be gradually progressive in the size and the amount of firings to be done on given flights.

It was assigned to STS 61-C for the first time because it required a software implementation to allow it to be precisely controlled, and that first was available in the OI-7 software which flew first on STS 61-C. Also, 61-C had sufficient propellant margins to perform the test, and so it was implemented to be done for the first time on that flight.

To my knowledge, there was not a concern during the flight regarding aerodynamic control of the vehicle. There might have been one, but the technical issue that arose had to do, rather, with respect to the second issue you mentioned, and that is the age of several of the engines on *Columbia.*

We proceeded with the plan, we had the test built, we started the flight. About 2 days into the flight, we began to see the actual temperature of the propellant system, including the tanks, and so the team in the evaluation room in Houston and in Downey began reviewing this test to be sure those temperatures and all aspects were correct.

The Marquardt Corp., which provides these RCS engines, was brought into those discussions, and in that deliberation it was recalled—I would think would be a good word—that there were eight RCS engines in the program which had oxidizer splitters made out of titanium in their oxidizer system as opposed to columbium, which is on all other RCS engines.

The concern we're talking about is a concern called a zot. When you fire an engine repetitive times, the oxidizer from an early firing can condense in the valve area, and then when the second firing happens, the fuel can mix with this lead of oxidizer and cause a detonation. It would, in its worst case, damage the valve seats, and the concern for 61-C was primarily oxidizer leakage from that kind of a zot postlanding and be a hazardous condition during the phase immediately after landing of the vehicle.

There are four engines with this titanium valve configuration on *Columbia* and four of them on *Discovery.* Those are the only eight remaining in the program, and they were allowed to remain in the program because, as you pointed out, Mr. Chairman, the forward RCS has never been used up to now during entry, and these zots only occur with aerodynamic pressure interacting with the detonation in the engine.

So they were completely satisfactory for orbital flight, and the fact that they existed had been overlooked in all of the prior reviews and discussions of this detailed test objective.

Probably the most specific single characteristic of why that occurred is that when the RCS valves were upgraded from titanium oxidizer splitters to columbium, the part number was not changed, so all valves carry the same part number, and this characteristic of titanium to columbium was tracked only by serial number.

Mr. NELSON. All right. You said that they were fine for orbital flight.

Mr. ALDRICH. Yes, sir.

Mr. NELSON. Were they fine for the reentry test?

Mr. ALDRICH. The valves with titanium seats had been tested only down to 120,000 feet, and related testing had indicated that

this titanium characteristic could be more zot susceptible, and so the testing was broken off there, and the columbium valve splitter engines were tested down to 70,000 feet, and some of the more specific tests of this DTO occurred between 70,000 and 120,000. So you would have to say they were not tested to perform successfully during the region that the DTO would be performed, and therefore there was suspicion——

Mr. NELSON. Less than 120,000 feet?

Mr. ALDRICH. Yes, sir.

Mr. NELSON. All right. And certainly not less than an abort either—the altitudes that you would be in in an abort.

Mr. ALDRICH. Control in an abort is done the same as it's done during a normal entry, and that is, the aft engines are used. So the forward RCS is really not implicated in a below 120,000 activity in the normal or intact abort landing sequences, and it was this DTO that got us into realizing we had this——

Mr. NELSON. Unless you were trying to dump your fuel.

Mr. ALDRICH. Yes, sir.

Mr. NELSON. As was the purpose of the test.

Mr. ALDRICH. Yes, sir.

Mr. NELSON. OK.

Now, out of all of that, Mr. Young, is Mr. Aldrich saying that the system caught itself on this question of flight safety?

Mr. YOUNG. That's very true, and it catches itself many times when people are flying. I wish I had a nickel, and I could probably name you a whole bunch of instances, but while people are up there flying, you get a lot more interest from both the contractors and every place, and I'm sure glad they brought it up then instead of postlanding.

Mr. NELSON. As this test—any of you—to Mr. Weitz, Mr. Crippen, Mr. Young—as this test was being considered, why do you think the system didn't percolate up that concern before the mission ever started?

Mr. Weitz.

Mr. WEITZ. I think, as Mr. Aldrich put it, it was just an oversight, Mr. Chairman. It was somewhat muddied, I think, by the fact that the engines were tracked by serial number only rather than a different part number.

Mr. NELSON. OK. Does everybody basically agree with that?

OK. All right, well, that's what we want to get, examples of, it's a complicated machine, and it's one in which you've got all kinds of checks and cross-checks, and you all had the response at the right time for that.

OK; Mr. Andrews.

Mr. ANDREWS. Thank you, Mr. Chairman.

Mr. Truly, your May 24 memo assesses that in the coming months all of you will be reassessing the safety factors in accordance with that memo. Will that primarily take place at the Johnson Space Center?

Admiral TRULY. No. As a matter of fact, the assessment is done throughout the system, depending on the specific item. Mr. Aldrich will direct a particular organization to do it.

Most of the mission planning, for example, assessments will be done in Houston with a mission planning and operations organiza-

tion. Assessments of KSC work forces and shifts would be done primarily at KSC. Assessments of propulsion hardware would be done at Marshall and then would come to him, you know, for review.

Mr. ANDREWS. Since the accident, some of the workers at the Kennedy Space Center and Marshall have been laid off, and the pace certainly has been slowed. There have been furloughs of not just a few workers but more than a few.

As we move toward returning the shuttle to operation, could either you or Mr. Moore give us some sense of when we can anticipate the hiring capacity will be back on stream again, and, more importantly, can we anticipate more short-term layoffs before we accelerate the program again?

Admiral TRULY. That's a good question, and I cannot give you a specific answer, except to say that we have been very careful in the layoffs that we have not wanted to do but had to do during our downtime to make sure, from a flight safety point of view, that we kept a core capability both at the Cape and at other places.

As we progress through the redesign and the qual, and as we approach the first flight date, we will have an integrated plan that will rebuild those work forces to match the planned first flight and the flight rates.

Mr. ANDREWS. Will there be more workers laid off? Can you answer that this morning?

Admiral TRULY. I can't. Can you, Arnie—I mean—I'm sorry—Jesse?

Mr. MOORE. Mr. Andrews, let me try to give you a perspective from JSC. As has been laid out here, we've really got our plate full at the Johnson Space Center, so I see our civil service team being employed very heavily in the shuttle recovery activities in addition to working the Space Station Program.

What we've done at the Johnson Space Center is just not build up as rapidly in some of our contract transitions that are currently going on right now. We have the shuttle operations contract which was selected not too long ago. We've basically slowed down the rate of buildup of that particular contract. In addition, we have a flight equipment processing contract which has also just been recently announced.

So our plans will be not, per se, to lay off people but not to build up as rapidly as we would have built up in our previous plan prior to this accident. So I don't anticipate, at least with the data that I have available now, any layoffs at the Johnson Space Center in the near term.

Mr. ANDREWS. All right.

Mr. NELSON. We have the Dannemeyer substitute before the House right now. We'll break and vote, and then we'll come back and resume with Mr. Andrews.

[Recess.]

Mr. NELSON. The meeting will come to order.

Under the rule, on consideration for the budget, there will be now 2 hours on the Leland substitute, 2 hours of debate. So we'll have 2 hours now before we're interrupted for the next vote. So we will continue with Mr. Andrews and his questioning.

Mr. ANDREWS. I'd like to go back to my last question and ask it again, and let's discuss it in a little more detail.

There is great concern, not only at the Johnson Space Center but at the other centers around the country, about potential layoffs and discharges as a result of the accident and the setback of the overall program.

I think it's primarily important in terms of encouraging better morale and getting us back on to the program, and I can certainly speak personally from what's going on at Johnson, to have a good sense of feel for what happens next. What can an engineer, or an astronaut, or someone that works at the Cape anticipate about their job security in the coming months, short run and long term? And I'd like for Jesse Moore and Dick Truly, if you would please comment again. The question, I think, is, do you anticipate there will be further layoffs or discharges before we get this program back on track again?

Admiral TRULY. Let me comment briefly on the major layoff locations other than the Johnson Space Center, and I'll let Jesse Moore remark to that.

The layoffs that occurred at the Thiokol plant have essentially—all the people have been recalled except for about 70. We don't anticipate future layoffs at this time there, and we have gone back from a 4-day work week back to a 5-day work week, and this represents a step up in their support, in their design efforts, in preparation for testing.

At Michoud, it's my understanding that most of the people were transferred to other divisions within the Martin Co., and they have terminated some service contracts. However, I think mostly it's been an internal movement.

The situation down at KSC is approximately 1,100 people were laid off, which has been previously announced. At this time, we do not anticipate further layoffs, and of course that will depend on us making the schedule that we believe is possible, which is a July 15, 1987, launch, and that will have to be reassessed as the budget unfolds and the schedule unfolds during this year, and then, based on the flight rate, we're going to have to just reassess the situation at KSC, and we'll be as forthcoming as we possibly can when that's done.

With that, I'd like to turn it back over to Jesse and let him comment on the situation at Johnson.

Mr. MOORE. Mr. Andrews, as I had said earlier, you know, we're putting in place at Johnson two major contracts. One is the shuttle operations contract, which has been won by the Rockwell, and at the present time what we're trying to do there is to hold our current level until we get back flying again and start building our rate back up.

So I'm not anticipating any reductions in that particular area as far as the ops contract is concerned that we've got in terms of the long-term operations aspect.

We also have initiated and selected Boeing for the FEPC contract, which is the Flight Equipment Processing Contract. Our plans there will be also to kind of retain a level through this period of time until we get back in the air and not build up as rapidly as we had anticipated building up, so we'll have a slower transition period in that period of time.

In addition to that, we are holding some people at Rockwell on production in anticipation, if the agency gets approval to go ahead with another orbiter, which would be some additional work there to get started on the development of a fourth orbiter now, and also, in addition to that, we are spending a lot of effort, as you well know, at this point in time, and gearing up for the new start, hopefully, on the space station in fiscal year 1987.

Mr. ANDREWS. Which is on schedule.

Mr. MOORE. Yes, sir.

We have our work in place, we are ready to go with a new start in fiscal year 1987, and we're in the process now of preparing our request for proposals for the C/D contracts part of the space station at this point in time.

In other activities we're putting a lot of effort at the Johnson Space Center on some new astronaut areas—automation, robotics, biotechnology, and so forth—and, in addition to that, during the down time, Mr. Crippen, Mr. Young, and Mr. Weitz can speak a little about a lot of the activities the crews are doing with respect to training, running our simulators, doing some things that we had planned to do over a longer period of time; we now have some time to do it.

So I think our people will be productively employed during this period of time, and, as I said before, I do not expect any additional layoffs. In fact, I don't think we've had any layoffs at the Johnson Space Center. So I really don't expect any layoffs at the Johnson Space Center over the near term based on today's forecast of the work to be done.

Mr. ANDREWS. Admiral Truly, at an earlier hearing you and I discussed the Civilians in Space Program. It concerns me greatly that we now face the loss of an orbiter and are attempting aggressively to get back on schedule to do the things we think we must do, not only on the military side but on the civilian side, and where every inch of that shuttle bay becomes precious, every pound becomes important, every moment is paramount in trying to do the research and the experiments that are so necessary to get us back on track, I really question whether or not the Civilian in Space Program is appropriate at this time.

Then, finally, in view of the safety problems that are involved, is it not appropriate to delay that kind of program to a future stage of the Shuttle Program? Does it really make sense now, with the facts we have before us today, to put a journalist in space, or a senior citizen, or, as my friend and colleague, Mr. Walker, would like, a handicapped American? Does that really make sense based on the facts that we know them today?

I noted that you were quoted in the Washington Post that you're reassessing that program. That is a change, if that quote's correct, and I always believe what I read in the Washington Post. But I wonder if you would comment on your thoughts on the Civilian in Space Program.

Admiral TRULY. Yes, I'd be happy to, and I am happy to comment, because I was not totally quoted accurately in the article.

As you may know, a few years ago when the NASA Administrator had a task force that looked at the various issues about flying citizens in space, I was put on that task force, and I was the one

member of the NASA community that was on it. It was conducted by the NASA Advisory Council.

A great deal of effort was put into that study. It took well over a year, and even though I went into the study with a somewhat negative attitude, I must say that at the end of the study at least this group was unanimous in that they felt that the program had advanced to the point where we could fly citizens, and by that I mean nonprofessional, or not professional pilots or mission specialists, and we proposed a program that fit under the Space Act, under NASA's charter to tell the public about space, and out of that group what is now the Citizens in Space Program, the Teacher in Space, the Journalist, and so forth.

I think the situation has changed now, and, as I said in the other hearing—there was the part where that quotation came from—I think the situation has changed in that we now have a practical problem of getting back into flight.

The early flights are going to be, quite obviously, looked at very closely, and as a part of my strategy we certainly will not be flying citizens in space or other than pilots and mission specialists in the front end of the program.

I think it's a policy question.

Mr. ANDREWS. I'm sorry, Admiral. What do you mean when you say "the front end of the program"? What does that mean?

Admiral TRULY. The first few flights, although other than the first flight itself, we have not decided how many flights that we will not fly pilots or mission specialists, but that is what I was going to get to here.

We have made a number of commitments to fly payload specialists on future flights prior to the accident. What I believe that we need to do is use this down time to assess this question from a policy viewpoint, and I think Dr. Fletcher agrees with this. We need to reassess where we've been in the past, determine how many flights we should go with professional crews, and that is what I have proposed that we do. I think it's high time that we have a relook at that issue.

Mr. ANDREWS. Mr. Young, Mr. Crippen, I wonder if you would comment on the Civilian in Space Program and what your thoughts are about where we are today and what we should be doing in the coming flights.

Mr. CRIPPEN. I think Admiral Truly summed it up fairly well. I believe that in the past when that question was addressed, we were at a point in the program that we thought we could carry citizens in space, and we elected to go ahead and do that.

We're at a point now that, based on the accident and the priorities that we have in front of us, we should sit back and reevaluate it.

I personally thought in the past that it was a statement of confidence in the vehicle that we could carry civilians in space. I think maybe some of that confidence is not there amongst the entire country right now, and we need to go back and prove it.

I think at some point in time it will be appropriate to continue that program, but I'm not sure exactly where that is right now.

Mr. ANDREWS. Mr. Young.

Mr. YOUNG. I have to agree with everything that Admiral Truly and Captain Crippen have said, being ex-Navy.

[Laughter.]

Mr. ANDREWS. I told you, Mr. Young ate too much of that chili last Saturday at the chili cook-off contest.

Just one more area of questioning, then I will pass. In this morning's paper it was revealed that—this morning's Washington Post, that the President's committee is going to recommend strong recommendations that military activities really predominate the Shuttle Program, that there suddenly be a mix.

I'm concerned about what a policy like this will mean on space commercialization and specifically what it may mean to those companies, especially these small entrepreneurial companies, that anticipate using the bay, that are ongoing in developing their activity.

One in particular that I can think of intends to use the whole bay for its payload; they need the whole thing to get their satellite—their working equipment into space.

What does this mean to a company like that? What are the ramifications of a policy that the administration, we anticipate they're going to recommend?

Admiral TRULY. Well, if you were puzzled by the article on the front page of the Post today, I must tell you that so was I.

Mr. ANDREWS. Have you seen the report of the recommendations?

Admiral TRULY. No, sir, I have not.

As you know, the Senior Inter-Agency Group for Space has been dealing with a number of policy issues since the accident that range—that cover a broad range of supplemental—the question of a replacement orbiter, and one of the issues has been the policy of supporting the national initiative to create in this country a viable commercial ELV capability.

I've not personally participated in a single one of the working group meetings or the SIG meeting that has been deliberating this.

Mr. ANDREWS. Do you know why you were not included?

Admiral TRULY. Well, I was busy doing the things that I've been doing in the accident investigation.

However, from everything that I've heard, it's been my understanding that, first of all, that the commercial or privatization of an ELV industry has been one that's been debated and has not been decided.

We think that the crucial issue is the question of a supplemental so that we know where we stand in the recovery, because I personally think that the most important thing about assured access to space is getting the space shuttle back on the line. Also, we think a crucial item is a national decision on a replacement orbiter.

But in all of the things that I have heard that have been discussed, I have not heard anything about an increased militarization of the space shuttle. As a matter of fact, in some testimony that the Secretary of the Air Force and I have made together—we have worked very closely with the DOD—and a part of their plan to help the national situation is a proposal for an expanded complementary ELV capability that actually unloads military and national security payloads from the shuttle to help us deal with this na-

tional backlog that includes NASA science payloads, national security payloads, commercial and foreign communications satellite payloads that we're committed to, things like you mentioned. So I was puzzled by the article.

Mr. VOLKMER. Would the gentleman yield? Would the gentleman yield on that?

Mr. ANDREWS. I would be happy to yield.

Mr. VOLKMER. I'm glad it's brought up. This is the only thing—I've been here all morning to bring up.

Is it possible—first let me ask you, was Mr. Graham in any of the meetings with the SIG group, do you know?

Admiral TRULY. Dr. Graham has participated at one time or another in the group, but I have not.

Mr. VOLKMER. All right. Now the question I have, is it possible that perhaps you and Secretary Aldrich could get together and provide this subcommittee with a proposed list of payloads and numbers that you would have, let's say, starting—if we do start again, let's say, in July 1987, that would be dedicated payloads, whether it's the Galileo mission or the space telescope or what, and DOD missions, to see where we are as far as requirements are concerned, assuming, of course, we're only going to have three and that by 1987 we're still—DOD's still not going to have their ELV's ready, as I understand, until 1988.

Admiral TRULY. Yes, sir. The answer to the question is yes. As soon as we can, we are developing such a manifest that will result in a total national status, and we'll be pleased to provide it.

If I might, let me tell you where we are and the difficulties so far in having that information in enough—as much detail as you need, you know, quickly.

The first tough decision in order to be able to lay out that manifest was choosing a first flight date, which we now have estimated to be no earlier than July 15, 1987, and that's the date that we have said, and that is based primarily not so much on the specific solid rocket motor fix but on the test schedule that's going to be required to certify and qualify that repair.

The next major question that we're dealing with, and it's being done primarily by Arnie Aldrich at level 2, and in dealing with the DOD, and that is the fact that we have three orbiters. They are of different configurations and the *Columbia* has a different payload capacity than the *Atlantis* and *Discovery*. We have the question of the planetary missions, and the Centaur processing, and the Vandenberg launch vehicle—or launch facility testing that needs to be done, and we're sending the *Columbia* out there this summer to do that.

So that the next big decision that needs to be made—and we're dealing with that as quickly as we can—is the first year's flight schedule, because the first year flight schedule tells us how we have to flow the vehicles in the ground flow to do that, and then, once that's done, we can run out an out-year manifest, looking at our various requirements and the backlog and have more definitive data, and all I can say is, in the time that we have to struggle with these problems, we're doing it just as quickly as we can.

We are over the first hump, which is a flight date, and as quickly as we can resolve them, we will provide that to you.

Mr. VOLKMER. Fine. If the gentleman would yield just a little further.

Mr. ANDREWS. Sure.

Mr. VOLKMER. Basically, I appreciate your being able to forward this information in the future. I know it will take time to develop it. But right now we know that there are a number of payloads that NASA's going to have to fly, and some of which are going to take up the total bay, some of which will not.

We also know, basically, DOD can tell us or tell you how many dedicated flights they're going to need out at Vandenberg and/or parts of the bay out at Kennedy. Can you give us that information a lot sooner—just the numbers, the dedicated flights, et cetera—so we can have some idea? I'm very concerned about that article that came out this morning.

Admiral TRULY. Yes, sir.

Mr. VOLKMER. And I don't know how accurate that SIG article is, and I'm sure that you probably—if it is accurate, you probably have some disagreement with it, I'm sure. I'm not going to ask you necessarily to say so, but I have some concerns on what it means in the commercial sector.

Admiral TRULY. Yes, and so do we.

Let me take action to get you as accurate and as general data, and as quickly as I can, but it is going to take a while to be specific, and I can assure you we're working on it as quickly as we can.

Mr. VOLKMER. I yield back to the gentleman from Texas and thank him for yielding.

Mr. ANDREWS. In truth, I think what we all realize and recognize is that we can't do it all with three orbiters, that we're severely handicapped, and if the policy that is suggested by this article is accurate, the commercialization goals that we have as a nation will be severely handicapped, and we will certainly lose to the French and other competitors—international competitors—if we can't allow commercial interests full participation in the shuttle, and what the article implies is that the administration may be moving away from that, and I'm concerned about it, and I think every member of the committee is, and I assume that you share that concern and alarm by that kind of suggested policy shift.

Admiral TRULY. Well, I'm not so alarmed by the article, because it goes—it's at odds with what I've heard about the serious policy debate that is going on. However, I think the issue is and should be of major national concern, and that is why it has been debated and will be going quickly to the President for decision.

I'm just saying that the thrust of that article dealt with or implied a policy decision or implied a policy decision that implied more militarization of the space shuttle, and in all of the things that I've heard and dealt with in the past couple of months, I just haven't run into that one.

It is true that when we get to flying again the DOD has important major payloads that need to get into space, but so does the NASA science community and so do our companies that we have commitments to in the future, and we need to deal with all of those, and it's a very serious issue. But that article implied things that I just had not heard before.

Mr. ANDREWS. Thank you.

Thank you, Mr. Chairman.

Mr. NELSON. Thank you, Mr. Andrews.

And the other implication in that article was that there was an abandonment being discussed of commercial satellites from the shuttle, of which we have shared the feeling of this committee over and over again, that if that in any way intimates that we are going to allow as a matter of policy of this Government American commercial payloads to be launched on foreign launchers, then I can tell you there certainly is not the support of this committee and I don't think many committees in this Congress, and that needs to be repeated over and over so that as the Department of Transportation tries to articulate their position in that SIG space meeting, that they understand that that's not going to be backed up by the Congress.

Our chairman of the full Science and Technology Committee is here. I want to call on him.

Mr. Fuqua.

Mr. FUQUA. Thank you, Mr. Chairman, and let me welcome our witnesses.

Admiral Truly, how far along are you, or what progress is being made on the review of the flight safety operations that have been—I understand is being reviewed by your office? How far along are those?

Admiral TRULY. If I could, since Arnie Aldrich is here——

Mr. FUQUA. Well, I didn't know. Maybe Mr. Aldrich might——

Admiral TRULY [continuing]. And is specifically dealing with them, and I assume you are talking about the critical items list review and the overview.

Mr. FUQUA. Also, and safety review procedures for future flights, once we resume flights.

Admiral TRULY. OK. If I might, let me ask Arnie to tell you where he is.

Mr. FUQUA. Very good.

Mr. ALDRICH. Mr. Fuqua, the reviews that I discussed earlier, to a large degree, are structured across the whole space shuttle program from the level here at NASA Headquarters to my level at the NSTS Program at JSC, and, even more importantly, to each of the projects at the various NASA Centers and to their contractors.

Most of the reviews of the failure mode and effects analysis, the critical items list, the operations and maintenance procedures, are being applied with a bottoms up complete re-look that has to start in significant detail at the contractor level in the organization to be sure we get to the full depth of the technical aspects and issues to be considered.

Because of that scope of involvement, these reviews are going to take a good part of the remainder of this year to complete in each of those areas. However, we have assigned responsibilities to lead those efforts to various individuals within the NSTS program, and they in turn have put together specific plans and processes for each review to be conducted. Those are all under way. We review them each week in my office, and we're having regular reviews every month to 6 weeks face to face around the program.

One of the issues we're dealing with, however, is that in many of these key technical areas the same very strong technical people are

required to do the work. That is, the specialist in a systems area must really participate heavily in the procedures review; he also must participate in the failure modes and effects, critical items review; he must participate in the design assessment re-review; and so a fairly intricate process of connecting the reviews together and sequencing the schedule of our people and our reviews and our reporting is also part of the total activity.

I think I can say in direct answer to your question that all of these reviews are thoroughly planned, they are well under way, detailed schedules are in process, we are interacting regularly to review the progress of those reviews, and as the detailed work comes forward, there will be formal meetings, first at the contractor then at the level three project elements at each of the NASA centers, then at my level, and finally at Admiral Truly's level here at NASA Headquarters. That is almost the pattern across each of the reviews in the program in this safety reassessment arena.

Mr. FUQUA. Mr. Aldrich, what are your plans to involve, once flight operations are resumed—involving the flight crews in making some of the critical decisions regarding flight safety?

Mr. ALDRICH. There is a broad discussion——

Mr. FUQUA. And through the process of leading up to launch.

Mr. ALDRICH. There is a broad discussion in the program right now in support of Admiral Truly to reexamine the whole management control process, the management communication process, and the very structure of how the reporting is done leading up to flights and even as flights are in process.

Our efforts in the past have intended to involve members of the flight crew in our various program technical and formal deliberations. We certainly are reemphasizing that activity, and I personally will recommend to more formally involve crewmen in each of our program activities in the pre-flight preparation and in the flight assessments.

I think there are other elements of the program that also must be more formally involved than they have been in the past—for instance, our major contractors in the program—and I view a broader, more formal, more interactive process at each level as we review these flights.

Mr. FUQUA. Let me commend you on that.

Admiral Truly, one last question. How soon after—you indicated a target date of July 15, that there may be a possible next launch. How soon after that launch would NASA be prepared to launch out of the Vandenberg launch facility? Is there a time frame, or is that possible at this particular time?

Admiral TRULY. As I discussed just a minute ago, that is the key next decision that we have to make, and that is the first year's operation, and it's so crucial to us because it dictates the flows of orbiters that we can make.

Mr. FUQUA. In other words, it could impact the schedule at KSC.

Admiral TRULY. It will impact. All of these things impact each other, and what I don't want to do is get, well into the schedule and close to flight and have a problem crop up, say, at Vandenberg or perhaps with any one of the other threat areas, and have it undo the entire schedule. That's what we're struggling with.

To answer your question specifically, I think the earliest Vandenberg flight on any of the options that we have looked at is in the spring of 1988, and other options of this first year of activity would put it sometime in 1988.

One of the reasons for the diversion of estimates is, you may be aware of a technical problem that the Air Force is dealing with the Vandenberg launch facility which has to do with entrapment of hydrogen underneath the flame ducts, and the fixes for that problem are not defined. The simplest one would allow spring 1987 potential first flight. If the simpler fixes are deemed to not be adequate, the schedule for them will delay it later in the year.

You also need to remember that we are going to have to flight——

Mr. FUQUA. During the spring of 1987 or 1988?

Admiral TRULY. I'm sorry, 1988.

Mr. FUQUA. OK.

Admiral TRULY. We also are going to need to do a flight readiness firing at Vandenberg prior to the first launch, as we have done for safety purposes at the Cape.

So, as I said earlier, this is the next difficult decision we need to make about which major payloads—how to schedule those first major payloads. Once we do that, then we ought to be able to very quickly run out an out-year manifest and move on to the next decision.

Mr. FUQUA. There has been—Dr. Graham has been quoted as saying that there would be no safety waivers. I believe maybe you've been quoted as saying that on any of the launches. Is that still the policy or is that still your intent?

Admiral TRULY. I wouldn't say there will never be another safety waiver. I will tell you that we will never launch without being satisfied that we have made the right decisions based on flight safety. Safety waivers, for example, come in various categories, depending on specifically what the decision is.

For example, we have set landing weights, and if we are 500 pounds even over an agreed upon certified landing weight, that does require a waiver, and you could refer to that as a safety waiver. We have done that in the past. But I can assure you that we're not going to launch again and we're not going to keep launching without flight safety being our first concern.

Mr. FUQUA. Thank you very much, Mr. Chairman.

Mr. NELSON. Yes, sir, Mr. Fuqua.

Mr. Walker.

Mr. WALKER. Thank you, Mr. Chairman.

I have here in front of me the two flight safety memos that I think the committee is probably working from for the hearing today, the one first of all generated from John Young on March 4 about the concerns that he had with shuttle program flight safety, and then the one generated by Admiral Truly on March 24 regarding returning the space shuttle to flight status and the safety concerns there.

Let me ask you first, Admiral Truly, do you regard your March 24 memo as responsive to the March 4 Young memo?

Admiral TRULY. No.

Mr. WALKER. So it was not seen as a memo that followed up on the concerns expressed by the Young memo?

Admiral TRULY. No. Let me recall for myself and for you the situation that caused me to write the March 24 memo.

I arrived on the scene about a month after the accident. At the time the Presidential commission was getting into its investigation, at that time, Jesse Moore had taken over the interim group, a NASA task force at the Cape, that had been trying to understand this terrible accident, and the first thing that I saw was a need to first go to the commission, which I did, assure them that they had my absolute, full, and unqualified support in their investigation, and to organize or to better organize the total NASA effort, which I did, to support them in their investigation. This took several weeks to accomplish.

The next thing I saw, that even though at various levels of the organization, primarily at the direction of Arnie Aldrich, that a number of things that had been set in motion, no one had had the time or had put together a total overall strategy that put all the things that we thought needed to be done in order to safely return to flight, and so I decided to sit down and take on that task, and the result of that was the March 24 memo which was my strategy for returning to flight.

Certainly a part of that was talking to John and to other crewmen. A part of it was talking to Arnie. A part of it was looking at what was going on in the public view of the investigation, and I just felt like it needed to be pulled together so that the Congress and the public and, very importantly, the people within NASA could have a single strategy and be able to face up to this mountain of work that we knew would be required, and so that was really the reason that I put that memo together, and it was not in response to John's—any conversation that I'd had with John, any of his memos, or any other single thing.

Mr. WALKER. Is this still the operative memo within NASA with regard to return to flight safety?

Admiral TRULY. It is.

Mr. WALKER. Has it been at all amended since it was drafted and distributed?

Admiral TRULY. No, it has not.

Mr. WALKER. It has not.

So, in other words, the policies as defined in that memo of March 24 are the policies of NASA for returning to flight safety, and what you are now doing is expanding upon the details within that memo. Is that a fair assessment?

Admiral TRULY. That is exactly correct. I don't remember the words, but for each of the actions in the memo, for each one except for the program management assessment and the organizational assessment, I assigned the level 2, Arnie Aldrich, to take charge of the detailed work that would be required to implement the specific direction.

In the case of the program management and organization, that's one, since I felt like it would certainly come above the level 2 and up to the headquarters and was so crucial, I took personal responsibility for that one.

I must tell you, the status on that is that Arnie, for me, is developing a base of inputs and opinions as to where he thinks—the suggestions that he's going to be making, and I'm going to do the same thing with the center directors. We have time to deal with that, and that basic program assessment, it seems to me, encompasses every item that I've run into in the investigation where I think things are less than perfect, but it hasn't been done yet.

The other organizational effort that is going on that Dr. Fletcher has just announced is that he is asking Gen. Sam Phillips, who was a former Apollo program manager, to make a several month organizational look of the entire agency, both program management and institutional relationships, and I view those two things—what's in my March 24 memo and Dr. Fletcher's direction to Sam Phillips to get that help—to be possibly the most important thing that's going to come out of this year, but I've got a lot of work to do.

Mr. WALKER. Well, if this is in fact the operative document of which NASA is now working, it seems to me that it includes a large number of things that are having to be changed in the agency with regard to flight safety.

Do you regard the memo as an indictment of the way things were operated in the past?

Admiral TRULY. No, as a matter of fact, I don't. Nothing in the memo directs change, with the single exception of the SRM design group. What the memo does is, it requires us to reassess our entire structure.

I, frankly, think that much of our structure that is in place is a good one. I think you can't change everything by changing organization, and I am not making any apology for the mistakes that we have uncovered that we have made and we will change where required. But I think what we need is an honest relook at ourselves, and that's what the memo directs.

Mr. WALKER. Well, Mr. Young, if the memo is the operative memo and it does not necessarily require change in the way the agency has been proceeding, then is the memo and the process that has followed the memo responsive to the concerns that you raised on March 4?

Mr. YOUNG. Let me go back and not quite answer your question right off, why I wrote that memo.

This was a month after the accident. We were attending panels, and boards, and meetings all over NASA. We had a lot of people participating in the accident reviews, and it wasn't clear to me, it wasn't clear to a lot of people in the Astronaut Office, that we were going to do anything different on the next flight than we'd done on the one before, and so I wrote that memo.

It was an internal memo in NASA, trying to get people enthusiastic about doing it a little differently next time, and that calls for a change mostly of attitude, I think, across the agency, and so I wrote that memo, and I'm not sorry that I wrote it. And I wouldn't take back a word of it.

When you go to meetings and you sit in those things, and people say you've got to do this and that and the other thing because it's a technically correct thing to do, and it's a safe thing to do, and somebody next to you says, "But that might hurt the launch probability," why, after you just lost seven people, you take a very dim

view of that kind of approach to things, and that's why I wrote that memo, and if it requires an attitude change, and if we have to get back to this right here, "What Made Apollo A Success?" then that's the way we ought to do it, because we need to fly this machine safely, and I think that's the direction that we're headed, as a matter of fact.

There's an awful lot of good people in this agency, there are a lot of good engineers at the working levels that know exactly what the problems are; I'd be glad to sit down and talk with you forever about them; they've been trying to get them fixed since Hector was a pup, and we ought to do those kinds of things; I think it's very important. I think it's a good outfit and we can do it.

Mr. WALKER. But you raise some legitimate, specific concerns in your memo, and what I guess I'm interested in, as a member of somebody who has to fund the program of recovery, is whether or not you think that the fixes are going to be made under the program that is now in place in the legitimate, specific concerns that you brought forward in your memo.

Mr. YOUNG. Well, every one of the design type concerns that I have in my memo were not discovered by myself; they had been discovered by people in subsystem levels all over the agency, and we discussed them.

Every one of those design concerns right now, to my knowledge, has a design review number associated with a change request that Arnie's addressed already, most of them many weeks ago. The operational concerns are being reviewed in this Launch Abort Reassessment Committee, which is 150 people working to reassess the safety of that, and the other concerns are also being addressed in various areas all over the center.

I think that the process is not specifically addressed in that memo, but the process we're going to have to go through to get back on track is being done, yes, sir.

Mr. WALKER. But you say in your memo, "An urgent request that whatever management method it takes, we must make flight safety first." Now are you convinced that the process that we are now going through is going to make flight safety first, particularly when you hear a discussion a moment ago that suggests that we might allow some safety waivers in the future?

Mr. YOUNG. Well, you have to understand what Dick is talking about. For example, the landing weight of the space shuttle orbiter is 211,000 pounds, and if you go above that, you have to get a waiver for it. We landed STS-9; it weighed 220,000 pounds, and of course we did it on a lake bed. So you do have waivers that come along that aren't particularly critical, just because it hadn't gone through all the certified wickets.

Now there are some waivers that people have made in the past that I don't think will be made in the future, and that's the important change that's being made. You won't make a safety waiver just to meet a launch schedule.

Mr. WALKER. You don't think they'll be made in the future. Do you know that they won't be made in the future?

Mr. YOUNG. We're going to be following that very closely.

Mr. WALKER. Well, do you think that you should be sure that they won't be made in the future?

Mr. YOUNG. I think the system should be sure that it won't be made in the future. It's impossible for any one group of people to follow the whole thing, but I think the system can be made to work that way, and that's just what we ought to do.

Mr. WALKER. I have some additional questions, but I'll wait until after the other members. Thank you, Mr. Chairman.

Mr. NELSON. OK. Thank you, Mr. Walker.

Mr. Torricelli.

Mr. TORRICELLI. Thank you, Mr. Chairman.

Mr. Chairman, let me first associate myself with your remarks and those of Mr. Andrews concerning the possibility of a retreat in formation by the administration on the question of a continuing NASA role in the deployment of commercial satellites.

If it is anyone's intention in this administration to lead such a change in national policy, they had best be prepared to meet a congressional buzz saw of opposition, because those sentiments are certainly not shared, in my judgment, by many members of this institution.

Let me ask you, Admiral. As you are looking at the universe of possible design and engineering changes of the entire shuttle system, are any of those possible changes so fundamental to the design of the orbiter itself as to warrant further delays in the beginning of construction of the fourth orbiter?

Admiral TRULY. Let me answer you very briefly and let Arnie comment, because the way the system works is, he sees the changes coming before the controversial ones will get up to level 1.

There are some changes being debated—and I don't know whether they will be required or not—that could delay that flight date that I gave you.

Mr. TORRICELLI. Beyond the flight date, I'm talking about the construction of the replacement orbiter, and the thrust of my question is whether the intentions of many of us to have this country to begin immediately——

Admiral TRULY. OK. I understand now.

Mr. TORRICELLI [continuing]. Funding and reconstruction, the design changes can be incorporated during that construction to warrant all possible concerns without any further delay in beginning the purchasing of parts and the basic construction of the vehicle.

Admiral TRULY. I believe the answer to your question is no, but let me let Arnie do a double check.

Mr. ALDRICH. I would agree, Mr. Torricelli, with Admiral Truly on that, with one exception. In my opening statement, I mentioned that I'm sponsoring a complete reassessment of the crew survival and abort capabilities from the space shuttle and consideration of enhancements to that system that the organization might deem feasible.

There are some flight phases of the space shuttle missions that would be very difficult with our current design of the space shuttle systems to provide significant additional crew survival capabilities. For instance, the first 2 minutes while the solid rocket boosters are burning.

In the course of these deliberations on crew survival and additional abort provisions, if in fact the agency, not up through myself

but through Admiral Truly and probably through the administrator, decide that significant changes in the abort and crew recovery features of the shuttle would be implemented, then we would have a deliberation that would affect significantly downstream designs.

I have no indication that features that would provide those kinds of extensive capabilities would in fact be practical or would be stumbling blocks for this program to move forward, but I believe it's prudent to wait until these design studies and reassessments are made and brought forward and the agency concludes where we want to come down in those critical areas before you can give a completely firm answer to your question that we might not want major features——

Mr. TORRICELLI. Well, what in your estimation now is the lead time on the construction of a fourth orbiter? How much time are you currently seeing for the parts acquisition and construction phase?

Admiral TRULY. Because of the availability of the structural spares that have been funded in previous years, it's my understanding that from authority to proceed to roll out at Palmdale is about a 3-year period, and from then to first liftoff at the Cape is about another 6 months. So it's about 3½ years.

Mr. TORRICELLI. So can I summarize your remarks that during the course of that 3 years you see opportunities to do design changes and retrofitting to meet all safety concerns while acquisition of parts and construction is in progress?

Mr. ALDRICH. I would see our ability to make the critical design changes that we must make before first flight to proceed and hopefully support the July 1987 goal of a first launch.

We will also be addressing additional enhancements to safety and performance that are good for the shuttle program, and I'm hoping to see them progress in the months following first flight to be incorporated not only in the orbiter fleet that we will be flying but in later downstream orbiters as they're approved.

I would not see, hopefully, the fleet departing with a new vehicle with a significantly different configuration, but hopefully forward work and retrofitting will achieve all of the good features that come out of our reviews.

Mr. TORRICELLI. If there's a 3-year construction time and then 6 months to launch of the fourth orbiter, should we assume that the months that have now followed from the time of the *Challenger* accident are simply lost in putting that fourth orbiter into operation again?

Mr. ALDRICH. I believe we're essentially waiting for that decision.

We have, as Mr. Moore mentioned, retained some of the manufacturing work force for a fourth orbiter, and the structural spares program is proceeding. So some progress is being made, but it's not the kind of start that gets you moving——

Mr.TORRICELLI. But, in effect, our country has lost the time.

I make the observation, obviously, because I think we all followed the President in his determination that the loss of the *Challenger* would not be reflected in the loss of a national will, that we all shared a continuing commitment to the Space Program

But, in fact, our words have not to date been followed by deeds. We may have a national commitment, but we have not committed

national resources, and that is why I think it is important for this committee to recognize that on the bottom line the necessary design changes can be incorporated during construction, so there is no cause—no reason for delay, and that every day that passes is another day until we again have a full national access to space.

Let me move on to a different question, if I can, in the little time I have remaining.

On the redesign of the solid rocket boosters, I know you have a design team working on the problems, and I know that Morton Thiokol is involved in that process. I think you are also aware of an intent by many Members of Congress, and some on this committee, on the possibility of bringing other companies into that process, either fully in a second source or immediately, using their expertise.

Could you, Admiral, explain to me why it is that other corporations that have an expertise in the solid rocket technology are not at this point working on an equal basis with Morton Thiokol, assuring that we have the best national talent available in the redesign of the solid rocket boosters?

Admiral TRULY. Well, as a matter of fact, the design team is getting technical assistance. Morton Thiokol, as you know, is our prime contractor for the solid rocket booster, and the design team itself is made up—even though it's located at the Marshall Space Flight Center—it is made up of people not only from Marshall but from other NASA centers and is getting support from other external organizations, and an oversight committee to that entire effort, including not only design but certification and testing, will be shortly announced that will report to Dr. Fletcher and will stay with us from now, into flight.

Mr. TORRICELLI. Maybe I should have phrased it more in a philosophical vein. It would appear to me that if our priority is the redesigning of the solid rocket boosters, and that our priority is safety, it could be agreed by all that safety would be enhanced the most by going out to various corporations that have the technology and suggesting to them, "We want to see design changes by each of you, we want to give an opportunity for each of you to participate in the future of this program; fight it out; let's see who has the best technology; let's see who can do the best re-engineering," and use what is our best national resource, which is competition.

It appears to me that, despite the sad history perhaps of what has happened internally in the Thiokol Corp., we are returning back to base one rather than home plate and letting new people back—letting new people participate from the beginning here.

Admiral TRULY. Well, I think that the design team has invited and is searching for a variety of the best ideas from the best people that they can find. I'm confident that that is in fact what's going on.

I do think that the studies that we've made in the past for second sourcing of a solid rocket motor are ones that are important to us and we are addressing. As a matter of fact, I have the action to report to Dr. Fletcher just as soon as I can as to my recommendations about second sourcing for the solid rocket motor contracts. That effort was started before I arrived on the scene. As a matter of fact, Mr. Moore may be able to talk to it better than I because

he was Associate Administrator when it started, but it had been considered for some years.

The simple fact is that in the very few weeks that we've had—and they are few weeks—my primary goal and emphasis has had to be to support the commission that has not even reported out yet on the investigation and to try to put into place an overall program plan so that we can get back to flight as soon as we can, and I think that the efforts and encouragement that I have given to the design team, both directly and through Arnie and through the management at Marshall, is to look at any place they can find for any idea that is to assure that whatever fix we choose meets our requirements of flight safety.

Mr. TORRICELLI. I understand that, Admiral, but let us just conclude this issue then by saying that there have been strong congressional suggestions in the past on the need for a second source on the solid rocket boosters. Those are suggestions that NASA has seen fit in the past not to take.

Suggestions in this institution have a way of evolving into commands over time, and that may be the stage in which we are now entering.

But I think it's fair to say that many of us hold the belief that our country would be better served at this point by having more than one company involved in the final development and preparation of those solid rocket boosters.

Let me finally then ask, this now well cited Washington Post article today contains several other words that I found startling. If I could quote it, it refers to the space station as a recently revealed "scaled down version." I had not seen on this committee any congressional intent, based on our current problems in the space program, to scale down a space station, and I knew of no such direction from the President. Could you please explain what the Post may have had in mind by citing a "scaled down" space station?

Admiral TRULY. No, sir, I can't explain what the Post had in mind in the article, and the space station is one thing that is not my principal responsibility. I might ask——

Mr. TORRICELLI. Well, let's ask Mr. Moore then.

Admiral TRULY. I might ask Jesse Moore, who is the lead center for the space station, to comment, though.

Mr. MOORE. Well, Mr. Torricelli, I don't think we're working any scaled down space station. I think what the agency has testified before to this committee and what it's testified at other congressional committees is where we're going forward on the space station, and the implications of the Washington Post article on scaled down space stations is unknown to me at this point in time.

Mr. TORRICELLI. That's reassuring, and from this member let the intentions be clear that in the development of the space shuttle and space station there will be no national retreats. I don't believe that scaled down versions of anything are appropriate.

We have had a national tragedy, and we will respond with our best national resources and talent and go forward. But I am troubled that the early commitments after the tragedy of the shuttle have not been followed by equal will, and each time someone talks about a lessening national effort, if only in these veiled terms, I

think it's necessary to respond that there is no national retreat being contemplated.

Thank you, and thank you, Mr. Chairman.

Mr. NELSON. Mr. Moore, why don't you answer Mr. Torricelli's question with regard to what happened previously vis-a-vis the second sourcing on the SRB's.

Mr. MOORE. We put out an announcement in the Commerce Business Daily over a year or so ago soliciting interest from industry on the second source. We got four such companies that were interested in competing for potentially a second source.

We spent some time in NASA evaluating this and internally reviewing whether or not we should go forward with the second source, and we were trying to identify points of rationale as to why it's important to go forward with a second source—economics, to have a second supplier in the event something happens to our primary supplier, and so forth, and we came to the conclusion several months ago that the agency should go forward with a second source, provided the industry was willing to up front fund some of the facilitization.

We had seen numbers in the cost of getting facilities in place on the order of $80 million to roughly $100 million to put the necessary facilities, the test systems in, in order to qualify, and so we had gone out back in the late fall with a solicitation to see if the industry were interested in providing that up front and then guaranteeing the potential winner of a second source competition provided that a competitor was able to successfully demonstrate to Government standards that they qualified to build the solid rocket motors from a standpoint of reliability and safety and performance, and once that was demonstrated, then NASA would guarantee a percentage of buy of the follow-on procurements of the second source.

So that's kind of where we left it around the end of the year/early part of the new calendar year, 1986, and I think Admiral Truly is right. He now has the action, to come forward with what NASA's recommendation is on where we are today.

Mr. TORRICELLI. If the gentleman would yield just for a moment, I think that those actions were a positive development, and I genuinely commend you for them. As you know, it is the belief of some, however, that a genuine second source must contemplate the different corporations competing on an equal basis.

Mr. MOORE. Yes.

Mr. TORRICELLI. It is not a competition between Ford and General Motors if the Government offers to build Ford's factory and then see who comes up with the cheapest car. That is a little bit of what we are considering here, and I understand the restraints in the Government making investments at this point in developing a second source, but, nevertheless, I think the bottom line by all of us, we would agree, is that long term, if we do make a national investment in developing a second source, there are tens of millions of dollars to be saved by that competition within NASA bringing down the cost of that solid rocket fuel.

Mr. MOORE. Yes.

Mr. TORRICELLI. And so we have the same objective, saving money. It is simply the belief of some of us that if we did in fact

make a national investment early, the long-term savings would be significant. But I do commend you on the early work that has been done on this, and I think in the next few months we can do even better.

Mr. MOORE. Yes. Mr. Torricelli, one other point is that, realize that it will take time, is another element in bringing a second source on line, and that's certainly one of the factors you have to consider to start out to make sure you have the production capabilities in place, you've gone through the certification firings necessary to ensure that you've got a certified, genuine second source, and that's on the order of several years to do that. So time is another element in this whole equation.

Thank you.

Mr. TORRICELLI. Thank you.

Mr. NELSON. Was a recommendation made to Administrator Beggs, and what was his response?

Mr. MOORE. The NASA position in the last part of the calendar year, Mr. Chairman, was that we would go forward and solicit industry again to see if they were interested in the proposition that NASA had laid on the table, like the industry would provide some of the up-front facility capital, and so forth, to get them in a position to be competitive, and we were in the process of planning to go out with a solicitation to make sure the industry was interested in pursuing this activity, and if they in fact were, then it was NASA's plans to go forward with an RFP to select a competitor.

Mr. NELSON. Was that the Administrator's decision?

Mr. MOORE. I believe that was the Administrator's decision, yes, sir.

Mr. NELSON. OK. You need to get to your 12:30 appointment.

Mr. MOORE. Yes, sir. Thank you, sir.

Mr. NELSON. All right. Let's turn to Mr. Smith.

Mr. SMITH. Thank you, Mr. Chairman.

I'd like to follow up on a point that Mr. Andrews made earlier. I think it was you, Mr. Crippen, who responded to it. As you know, one of your colleagues in the shuttle was a resident of New Hampshire, Christie McAuliffe, and if there was anybody, that I know, that really displayed more enthusiasm for the space program than she did.

In response to what Mr. Andrews asked you regarding future flights for private citizens, if you will, I didn't detect a great deal of enthusiasm on your part from that. How do you feel as astronauts regarding the private citizen on board the shuttle in the future?

Mr. CRIPPEN. I think that you will get a varied amount of enthusiasm throughout the Astronaut Office if you talk about having what we would refer to as potentially a passenger on board, because we've had people that have trained for many years to go fly, and I think some of them do view it as sort of an infringement upon something that they're doing when such passengers are put on board.

But my personal opinion is that that is a positive thing to do. I personally agree that those are reasonable things to pursue.

The question is at this particular time—which I believe is different than what it was when we made the decision to put them on board—since we've had an accident, we have to renew our faith in

this vehicle. I personally still have it, but I think we have to renew the faith of the country that it is a safe vehicle to take passengers with us, We have to sit back, reassess where we're at, go get the flight experience again, and then decide what we want to do regarding civilians in space, or citizens in space.

Mr. SMITH. I certainly agree that we need to somehow reestablish the faith in the shuttle and in the whole program, but it seems to me that, as we look back over the decisions that were made involving private citizens on the shuttle, that it was done because there was a great faith in the program, and it would seem to me, to pull back from that now, that faith has to come from the people, from the populace, if you will, a trust and faith in the program, not only for the financial support that we'll give on this committee and in the rest of Congress and the administration, but also just the support and faith of the populace itself.

It would seem to me that we should not pull back from that. If we've made that decision earlier because we believe that the shuttle could be successful and we need the enthusiasm, it seems to me we should stay with it.

I guess what I'm getting at is, personally, I don't think your life as an astronaut is any more or less important than the life of another individual, and I think I know what you're saying. You're saying that you guys, you're paid to take the risk, and I commend you for that. But I think that as long as individuals—private citizens—make these decisions and know—you know, they know they're taking the risk, why not?

It just seems to me, to suddenly say, "Well, we're not going to put a private citizen on board now because, well, something else might go wrong," it seems to me it sends a wrong signal.

If someone else would like to comment—I'm not trying to argue with you; it's just a personal opinion. I respect yours, and maybe someone else—another astronaut—might like to comment before I go on to the next question.

All right.

Just two more questions, Mr. Chairman.

Admiral, in your opening statement, you mention a number of specific points regarding safety, technical points about the solid rocket, and so forth—a long litany of them. At the top of one of the pages, you say, "We are restructuring the environment in which we work to further emphasize the methods by which technical and safety concerns are considered."

Could you just elaborate on that a little bit? In terms of the environment, of how you come up with these safety features, what are we going to do differently, and what were we doing wrong in the past in terms of the environment for coming up with these safety features? I'm interested in the term, specifically, "the environment."

Admiral TRULY. I think that despite the fact that people in NASA have historically had a tremendous—flight safety has always been in the very front of the minds of the engineers and people that work on it. But when you lose a vehicle and you lose a crew, and in the investigation where you realize that you, collectively have made a mistake, you feel a responsibility for that. Now your task is—because you believe in the program, and you funda-

mentally believe in the vehicle, one of which was lost, I think the environment has instantly changed, and, as Crippen said earlier, until you, collectively, and even in a larger sense, the Nation, collectively, has reestablished, the faith in that system, the environment has changed. Then flight safety becomes even more important than it was.

Most of the things we do are programmatic. We write an instruction, we give direction, we have a review. But in the final analysis, it's the people in the system that are going to get this done, and I would say that's the environment that has changed, and the focus on flight safety now has never been higher than it is today.

Mr. SMITH. One followup question on that, and then that's the last one, Mr. Chairman.

In the safety aspect—anyone can answer this, if they like; I'd like a point of view from the astronauts as well as from the engineers on this thing—you put a great deal of emphasis on redesigning the rocket, the booster rocket, obviously, because of what happened, and, at the same time, we made a decision a few years ago in the design of the latter shuttles not to have an escape hatch, not to have a way to get off of that thing or out of it in the early stages of the flight as we lift off.

It just seems to me to be a dichotomy to say now, We're going to really work to make sure this booster is perfectly safe, and, at the same time, you are looking at the possibility—or are you looking at the possibility of going back to an early abort method or perhaps even an ejection mechanism? I'm not sure what you have in mind. I'm not asking you to be that specific. But it seems to me that the astronauts, in flying in the last few years with the shuttle, pretty much put your faith in those boosters in getting you up there and therefore did not have that kind of safety mechanism.

I'd be interested in the response from both of you on that. Are we going back? Are we going to stay with that, or are we going to go back to the further safety point, which is, both work on the booster rocket safety and, at the same time, have a means to eject early or abort early?

Mr. WEITZ. Well, as Mr. Aldrich said earlier today, we are reassessing all aspects and considerations of the STS system, one of those being crew escape and survivability.

It was decided, for a multitude of reasons, that we could not practically and still meet, as best we could, the system capabilities that were laid on as design requirements early on and put a complicated crew escape system into the vehicle. When those decisions were made, I was doing other things, and John or Arnie may want to add to that later. I know it was accepted by all members of the Astronaut Office.

Mr. SMITH. What would change your mind now? Supposing the same engineers came forth and said, as they did a few years ago, The rocket boosters are safe, no problem, we don't need the escape hatch. What would be your reaction now in light of what has happened? I mean, would you fly again and support that?

Mr. WEITZ. I think all of us have already made that decision and in our previous appearance before the commission have stated that we accept as a reality that providing an any-time survivable escape capability into the present orbiter is not practical.

So we, through our involvement, as John briefed on earlier, will attempt to maintain an awareness from a very prejudiced and narrow point of view to help assure ourselves that the system is as safe as it can be.

Did I answer your question? What you'd really like to have, in an ideal world, is an escape module; you would like to have something that would get you off the vehicle at any time, lower you gently on to the land or into the water, and you have your own self-contained environment that will provide you survival for some number of days. But we cannot do that and still press on with this national capability.

Mr. SMITH. So your emphasis then, both from the astronauts' point of view and from the design, is that to perfect—further perfect the rocket?

Mr. WEITZ. Yes, sir, and it's very similar—well, it turns out, not by design, but all of us, sir, are carrier-aviators in other lives and at other times, and there are many things that can go wrong when you're operating around a ship, both in getting off the ship and getting back on. But we must have a system that addresses crew survivability in that situation also, and you do it by design to the best of your capability.

Mr. SMITH. Thank you.

Mr. WEITZ. And if you choose to engage in such endeavors, then I think you must be willing to accept some risk.

Mr. SMITH. All right. Thank you.

Thank you, Mr. Chairman.

Mr. NELSON. And that's certainly part of the reason we asked the three of you here today, to reflect from your point of view, as part of the active astronaut corps, on these questions of flight safety.

Mr. Smith, in part, on your question on emergency egress, going back to a question from Mr. Torricelli to Mr. Aldrich, on the question, if they decided they were going to have a major redesign, could it be incorporated within the 3-year time period of building that next orbiter? And I'm not sure that Mr. Torricelli clearly got your answer, Mr. Aldrich.

Mr. ALDRICH. Well, Mr. Chairman, a major augmentation to the space shuttle for a crew escape capability, particularly during first stage, is probably not consistent with the characteristic of the space shuttle overall configuration as we know it today, and therefore my answer would be no, I do not believe that it is consistent with that kind of a time period and maybe not consistent with any time period.

Mr. NELSON. That's specifically with regard to crew escape. With regard his overall question—and since he's not here, I'm asking the questions for him—overall flight safety, you see that within that 3-year period in which the next orbiter—replacement orbiter—would be built, you all would have sufficient time to incorporate any design changes into that orbiter, that is?

Mr. ALDRICH. Yes, I believe we could incorporate all of the ones which we would say would be required for first flight and many of the ones we'd like to see evolve as the program continues forward.

Mr. NELSON. Captain Crippen, you might imagine, since Mr. Smith is from New Hampshire, he was asking some of the questions with regard to the Teacher in Space, and I just want to point

out, Mr. Smith, that in the term that was referred to by Mr. Crippen of the passengers, understand that he's not only talking about the Teacher in Space but many other payload specialists that have flown, including a number of the international payload specialists.

You're including that within your commentary about passengers?

Mr. CRIPPEN. That is correct.

Mr. NELSON. OK.

All right. Now let's see. Who's next on the list?

Mr. Monson.

Mr. MONSON. Thank you, Mr. Chairman.

Admiral Truly, could you tell me where we are in the redesign of the SRB and what the schedule is from this point forward?

Admiral TRULY. Yes, sir. The redesign team has looked at many, many possibilities. We have not chosen a design. The schedule is based on our ability to use the hardware that we have. We ordered, I think, last summer, 72 case segments that have enough metal on them to accommodate a number of redesigns.

Our status is that we have—or the team has defined some design requirements for tooling so that that hardware could be machined to a future design when it is selected.

The preliminary design review is scheduled—help me, John; I think it's in July or around the first of July—and the critical design review is December of this year on the schedule.

There is a lot of development testing on competing designs that will be done in the next several months. As a matter of fact, some we have already begun testing on.

For example, one of the problems is, there is a so-called putty in the design that, in our investigation, apparently has not performed as we expected it to, and we intend to have a design that has no putty in it, so that we don't have that problem. So we have done some early small solid rocket motor firings without putty, with thermocouples at the joint, to begin to understand the phenomena of that.

Moving beyond the preliminary design review and the critical design review, the primary schedule drivers are full-scale development and qualification tests of a flight full-scale motor that we will fire and then tear down and examine the actual design as a result of those tests.

So it's primarily—the first flight in July 1987 is primarily driven by the test schedule rather than the specific design which has not been selected.

Mr. MONSON. Do you have a date in mind for that first firing—test firing?

Admiral TRULY. If I remember correctly, we're hoping to fire an engineering test motor to get some early data in, I believe, October of this year, and then the first motor firings that will encompass what I would call a flight design would be a development test motor after the first of the year, 1987.

Mr. MONSON. Getting back to the second sourcing issue, is it anticipated that they would use a completely different design, or would they fundamentally use the same design as the primary source is using right now?

Admiral TRULY. Fundamentally, I'm sure that we would not change the design since this new design will have gone through the extensive testing, and if we elected or recommended to go out with an RFP that competed a second source for the entire motor or booster, depending on how that comes out, it would be to our already certified design.

Mr. MONSON. And you indicated that you are preparing recommendations. Is that to——

Admiral TRULY. In the Office of——

Mr. MONSON. Dr. Fletcher?

Admiral TRULY. Yes.

In the Office of Space Flight, I have the action to assess the various factors that—you know, economic and so forth—that will allow the agency to make a decision.

As I said before, unfortunately, with so many other things, I've had to put that on the back burner. I know it is frustrating to all, including myself, and I'm a proponent of second sourcing where it makes sense. It's frustrating that we haven't been able to get to that, but it just is not as important as getting this investigation done, assisting the commission, and getting the design work in progress.

Mr. MONSON. Well, I can understand that, and I appreciate your priorities at this point in time. I'm just trying to get some idea of where we might be in deciding whether or not an RFP will be issued, and if you could help me understand that, I'd appreciate that.

Admiral TRULY. I am hoping to get my people to have the time to make that assessment and get a recommendation to Dr. Fletcher, in the next several weeks. I just haven't been able to get to that yet.

Mr. MONSON. One further question then. Inasmuch as requalification will be necessary, though, and since a second source would be using primarily the same design, does it make any sense to try and qualify two sources at the same time, or would the timing just be impossible?

Admiral TRULY. I think our present prime contractor, in qualification—and maybe Arnie could help me more. It's primarily, the building of facilities, the certification of those facilities, the test motors, demonstrating that a full-scale test motor firings can be made, and so forth, and essentially we've already done that with the present prime contractor.

Mr. MONSON. I understand.

Admiral TRULY. That qualification in the case of our present solid rocket motor went on over a period of years, and I would anticipate that that would happen again.

Mr. MONSON. It's not something that could be done quick enough then to meet the schedule of a July 1987 flight?

Admiral TRULY. No, it could not.

Our approach to that is to involve national expertise in the design effort so that we first can argue out what a redesign should be, and, as you can imagine, it is a lively argument on the various—considering the accident and the investigation, and we are not—we have had to start without the benefit of the recommenda-

tions of the Presidential commission, although we have had numerous discussions with the commission.

But in order to get the Nation back into the space shuttle business in what we think is a prudent and reasonable time, we've had to get this effort started, and I don't think that it will be wasted.

Mr. MONSON. I appreciate your efforts and appearance here today, and thank you, Mr. Chairman.

Admiral TRULY. Thank you, sir.

Mr. NELSON. OK. Let me tell you where we're going here. We have a live quorum call followed by a 5-minute vote. When we break here in about 4 or 5 minutes, that will give an opportunity for—if you all would like a sandwich, let's go ahead and take your order, and we'll have it sent down there to the snack bar and bring up your sandwich, and we're going to continue on. So let's proceed on that basis.

I'd also like to invite the members of the committee just to interject at any time, and we will get a free flowing of ideas at this point. All right.

I'll start it off, and I want to talk to the gentlemen from the Astronaut Office about, to what degree were you involved in the decision to launch or not to launch in the past?

The first question: Were you a part of the flight readiness review?

Mr. YOUNG. Yes, we participated in the flight readiness reviews in the past, and we attend, at least here, the L minus one briefings. But the kinds of things that were asked about in flight readiness reviews never involved flight crews or never were any issues that the crew could participate in. I don't think that if we had raised issues—and sometimes they were raised in a background sort of sense—I just don't think that the flight readiness review is the place for interjecting no-go's from the standpoint of the flight crew, unless you know something that nobody else knows anything about; that's not the place to do it.

The flight crew knows how to fly the space shuttle. They know how to operate the space shuttle. They know how to run all its systems. They know the capabilities and limitations of those systems. If there's something that's being done that is not, from a mission operations sense, being done correctly, they should have solved that problem long before they ever get to a flight readiness review, and most of those are solved to everybody's satisfaction before we ever get there.

So flight crew participation in flight readiness reviews, although we're there and we hear the issues, and we sometimes have concerns about them, and they're brought up, I don't think that we ever are in a no-go position in a flight readiness review or in the L minus one review either.

Mr. NELSON. Well, what degree did you or a representative of you representing the Astronaut Office participate in the decision, other than the flight readiness review, which you've discussed, and the L minus one review?

Mr. YOUNG. To launch 51-L?

Mr. NELSON. Excuse me?

Mr. YOUNG. To launch what mission? Any of them?

Mr. NELSON. Any of them.

Mr. YOUNG. I don't think flight crews, other than being there and listening to the discussions, participated in those. That's my feeling.

I think you could have got up and said, "Well, you can't go fly," for some reason or another, but you'd have better had a good reason to do it, and I don't think we've ever had those kind of reasons at the time to make any of those comments.

Mr. NELSON. Mr. Crippen.

Mr. CRIPPEN. Mr. Chairman, if I may, what John is saying is absolutely correct. We have been represented at all times at the flight readiness review, at the L minus one review. We're represented in the firing room, we're represented in the mission control, and we hear everything that's going on. While we're not formally asked, Are we go or no go? we are represented, and if we have a serious concern, we are in a position to bring it up.

So maybe it's a matter of perception. We are involved, and most of the kinds of things that we would bring up we bring them up much earlier than these particular kinds of reviews. Normally the kinds of things that we would be concerned about at the FRR or the L minus one, Arnie would also be concerned, and so those things are discussed.

Mr. NELSON. So the question is, are you involved in the information loop early enough in making the decision as this vehicle is prepared and the decision is ultimately made, go or no go? Is that the question?

Mr. CRIPPEN. The question starts coming up on a mission. It's worked, like, a year prior to the time, and we are constantly involved with decisions that are made regarding the mission. As you approach the actual lift-off, the formality of it, you go through some loops, and which we're involved there, not so much from a formal, Are you go or no go? but yes, we are involved. At least that's my opinion.

Mr. NELSON. OK. Then I guess the appropriate question at this point is, what, in the opinion of the three of you—and we will recess right now to go vote, and think about this: What, in your opinion, could improve the process in order to involve the Astronaut Office and this very valuable cumulative knowledge in the launch decision of go or no go? And I'll let that hang there as we vote, and we'll be back.

[Whereupon, at 1:00 p.m., the subcommittee was recessed, to reconvene the same afternoon.]

AFTERNOON SESSION

Mr. NELSON. The question that was left addressed to the three members of the Astronaut Corps is what improvements in the future, in order for you to have part of what you consider to be essential in the decisionmaking as to launch or not to launch. So any one of you please share with us.

Mr. YOUNG. In terms of whether to launch or not to launch, I think the decision process is better made by the line organization that does it, and of which the flight crew is part. They are asked if they are ready to go or not to go. Part of the go/no-go decision in the vehicle prior to that time in a formal sense, it might be good if

the flight readiness reviews were a little more formal and if more people were asked what their concerns were. It might be helpful to the program management and folks like that to do such a thing.

Before that time, though, which is where I think all our problems need to be solved and where everybody else agrees, we probably need to establish some mechanism internal to our various operations where concerns are more formally brought to the attention of people within the organization so that we can solve those problems ahead of time in things like areas that we are primarily concerned with, such as proper crew training and things of that kind, things that we can do something about.

I think other concerns such as systems problems or safety issues would have to be generally addressed in some other forum, and I think they will be in the future.

Mr. NELSON. Mr. Weitz and Mr. Crippen.

Mr. WEITZ. I agree with John, Mr. Chairman. The reason we are all here is because we had a failure on our last launch attempt which turns out to have been a design deficiency, and even if we wanted to, we do not have enough people or the proper expertise within the Astronaut Office, for example, for us to be able to intelligently discuss problems with and potential fixes to the field joint problem, for example.

I think that what is beholden upon the agency as a whole is to put in place a flight safety system adjunct, or whatever we want to call it, that is functional, and we have an obvious vested interest for desiring that. I think that that is one of the major tasks that is facing the agency because that is a lot easier said than done.

The ongoing system as we progress down toward any given event hopefully a flight or a design review or what have you, will have identified potential problem areas or soft areas, and that we would institutionally make our inputs into the resolution of such problems, which we do now.

Mr. NELSON. Mr. Crippen.

Mr. CRIPPEN. I think we are all saying the same thing. Perhaps we are saying it a little bit different. Formally with regard to what we are doing today with the launch decision process, I would not modify it to, say, put an astronaut in and then have Arnie, or whoever, ask will you go? I think that we are adequately covered.

Perhaps we should stress a little bit more in some of the assessments or meetings coming up to a flight the operational concerns. We have a forum for doing that today when prior to each flight we take the flight rules that are specific to a particular flight and go over them with our management, including level 2, and have an opportunity at that time to address any concerns we have. We might make that a little bit more formal so that we do drag any concerns out. But, again, nothing of that nature would have had any impact on this particular accident. It was a matter of a lack of knowledge that was throughout the NASA management that was making the decisions about it, so nothing that we could have done, or even putting an astronaut in that decision loop, would have made any difference to it.

Mr. NELSON. All right. Other than the question of the *Challenger* tragedy, you all are saying, the three of you, that you don't think that there should be more astronaut involvement in the decision-

making? Is that what I am hearing you say, than there has been in the past? Is that correct, Mr. Weitz?

Mr. WEITZ. Yes, sir. I selfishly might feel that some of our inputs might be given a little more weight, perhaps. When a decision does not go the way you want it, you tend to feel that you have been slighted, perhaps. But there are good reasons, I am sure, that the decisions that were made were felt to be appropriate at the time. And again, we are separating out the 51-L. We are talking about the process that is in place.

Mr. NELSON. That comes as a surprise to me because I got the tenor of Mr. Young's memo being different than that. What about that, Mr. Young?

Mr. YOUNG. Well, I think when it comes to safety issues there shouldn't be consensus type votes on the system, and I think in terms of operations the people who operate the machinery, which is flight crews and missions operations have to have a major say in that. What I was addressing was issues that I didn't feel were receiving adequate attention for that time, and I don't know that astronaut participation in those kind of things would help resolve those issues.

Still, I think it doesn't hurt to have people participating in every forum that they can have in these meetings and to have those people listened to throughout the agency. There is nothing wrong with that. That's the way NASA does business.

Mr. WEITZ. Mr. Chairman, if I might clarify; my response is based totally on the assumption that the agency will in fact have in place when we go fly next a viable working safety organization, and that the astronaut office will be represented at the signoff level when necessary as the system addresses safety issues. That is fundamental to everything I have said to you so far.

Mr. NELSON. I understand. Now help us understand, is that different from the way the system has been operating?

Mr. WEITZ. That is different from my perception of the way the system has been operating, yes, sir, because—well, because I don't know. That is what is going to make it difficult.

Mr. NELSON. That's different from your perception.

Mr. WEITZ. Yes, sir.

Mr. NELSON. But it is not different from your perception, Mr. Crippen?

Mr. CRIPPEN. There are two different levels, I guess, we are talking about. I am talking about the normal programmatic level where we work problems and address them when we are ready to go fly, and I don't think we are talking about streamlining that a little bit better and setting up ways to communicate better. That is what Admiral Truly is working.

In addition to that, we have proposed that there be a parallel Flight Safety Organization that would address problems, would give us a second line of communication to address those things that to my mind could or could not have astronaut direct involvement; but if we had a concern, that would certainly be a way to work it, although I would hope that we would primarily work it through the normal programmatic decision levels.

Mr. NELSON. All right, Mr. Weitz, you said that you want to ensure that there is this astronaut involvement on these decisions.

And you said it is different from your perception of the existing way that it is operating. So on the question of the day, which is flight safety, that is an improvement that you think should be made.

Mr. WEITZ. It must be made. It must be because successful aviation safety programs developed in DOD are separate from the line organization so that they can take in principle an unbiased focus and an extended view of everything you are doing, whether it be design operations, procedures, or what have you. My personal opinion is that what has to be, then, is some organizational element within NASA that, in fact, would report directly only to the administrator and no other levels within, and would have the authority and the responsibility to understand what is going on the field, to have the members of this organization be able go to any contractor's manufacturing facility, offices, drafting room, go to the Cape, any facility there, to JSC, to the simulator to find out really what is going on at the working level.

If you then raise the flag, it goes directly to the Administrator. Obviously, the concerned elements within NASA are aware of it and must then be answered by the people responsible for that element.

Mr. NELSON. You know, we spend a lot of time around here, up here on the hill, worrying about organization. You think such an independent flight safety office—is that sort of the concept that you are talking about?

Mr. WEITZ. That is what I am talking about, yes, sir.

Mr. NELSON. How about you, Mr. Young?

Mr. YOUNG. I think our organization charts are very interesting things, but I think unless you have the right people that it is totally academic to talk about flight safety, and that is the kind of thing that I recommend as being a pervasive organization that is up and down throughout the agency at every level that needs to be set up so that we don't let any of these safety issues, either operational or design or procedures get away from us. Sometimes we are all so close to the forest, we can't see it for the trees, and that is what we got to prevent, if you know what I mean.

Mr. NELSON. Yes, sir; we are trying to learn what you mean.

Let me go back to you, Mr. Weitz. You were giving an analogy there with a military operating model where they have a separate flight safety office. If that has been a model after which organizations have patterned themselves, particularly in hazardous kinds of activity, why has that not been instituted in the NASA operation?

Mr. WEITZ. I don't know the answer to that, Mr. Chairman.

Mr. NELSON. Does anybody at the panel know?

Mr. WEITZ. My point of view is prejudiced by my background.

Mr. NELSON. I understand.

Mr. WEITZ. I never had the responsibility——

Mr. NELSON. Let me ask Mr. Aldrich. Can you shed any light on that?

Mr. ALDRICH. No, Mr. Chairman, I really cannot. I think our NASA system and way of doing business has evolved over a number of manned programs starting with programs that were small, but had a lot of uncertainties, and we have a style of doing business and perhaps there should have been more self-reflection

on other ways to do some of the things we do. But I can't give you a specific answer.

Mr. WEITZ. In defense it is my understanding, and John can correct me if I am wrong, that our present SR&QA approach came about as a result of an investigation into the Apollo fire, right? And at the time it was felt by the Accident Board and the people who report on that that it was appropriate, and it seemed to be appropriate up until last January.

Mr. NELSON. Mr. Walker.

Mr. WALKER. If I could.

Mr. NELSON. Sure.

Mr. WALKER. Let me get to a specific with regard to the system. Who, if anyone on the Mission Management Team, has primary institutional responsibility for flight safety issues in the present system?

Mr. ALDRICH. If I could answer that, Mr. Walker, I believe that all the members of the Mission Management Team have that primary responsibility.

Mr. WALKER. But the problem is if everybody has that responsibility, then everybody thinks everybody else is taking care of details. My question is, under the present system who is it that really has the responsibility to make crucial decisions and to take the crucial look at the details? And I guess what your answer is is that there is nobody with that principle responsibility assigned to them.

Mr. ALDRICH. I think all of the key people that have the authority and the knowledge to investigate the different areas of the shuttle flight and ground systems make up that team, and they do have flight safety as their primary responsibility.

Mr. WALKER. I am willing to buy that everybody is concerned about flight safety and that they regard that as foremost in their concerns, but in terms of the management of the responsibilities of getting everything done, all of those people also have all kinds of other things that they have to be concerned about, which is their primary function, which is the reason why they are on the team in the first place, and while that may be a foremost concern in a generic sense, my concern is who has as a foremost concern within that operational element safety as their principal generic responsibility? Is the answer no one?

Mr. ALDRICH. Well, I hate to answer you the same way three consecutive times. Some of the people on that mission management team do not have a wide range of other responsibilities. They are specifically the managers for the shuttle hardware elements that we are addressing, and so they are directly involved in depth technically in those elements.

I am not trying to say that an augmentation of additional safety consideration is incorrect. I am simply trying to answer your question about our understanding of today's makeup.

Mr. WALKER. Let me put the question in another way. Would it make some sense, given what we now know, to have such an augmentation of the management team that would be essentially a safety representative?

Mr. ALDRICH. It is my personal belief, Mr. Walker, that we have strong cause to consider augmentation of the safety organization

across NASA at all levels, including the flight readiness and assessment process.

Mr. WALKER. Well, maybe I can ask the others, for example, would it make some sense to add a representative from the Astronaut Office to that team as a voting member with specific safety responsibility?

Mr. WEITZ. The reason I am hesitating is because any time—that is a significant responsibility with which it goes—I think that person would then have to be dedicated, so we would have to be willing to dedicate a billet from the Astronaut Office to that function.

I personally feel that it would be appropriate to have some person on the mission management team whose only hat he was wearing is safety.

Mr. WALKER. And who kind of looked at the rest of the systems as they are being developed and analyze them to make certain that as people were making decisions they were in fact taking the overall priority of safety and gearing that in. I mean that would essentially be the mission of that person; would that be your understanding?

Mr. WEITZ. Yes, that is correct.

Mr. NELSON. Let me follow that up.

Mr. WEITZ. Excuse me, but an individual can't do that. That is why I am hesitating, because we now come to a meld where we are going to interject, in your example, a member of the Astronaut Office into another relatively large organization. So he would have to become part of that. There is nothing necessarily wrong with that, but we can't just send somebody in and say, "Hey, look at me; I am an astronaut therefore I know all there is to know about safety."

Mr. WALKER. But you could do this—that is a legitimate concern, I think, but you know the reason why I think that I raised the issue of the Astronaut Office before is because the nature of the responsibilities of the astronaut in their training and everything else has tended to make them generalists about the system as a whole.

Mr. WEITZ. Exactly, and so many safety issues are very detailed, specific, engineering type issues that you will face up to such as a seal, such as a bearing or a turbine or a pump or what have you that a member of the astronaut office may not be the appropriate individual to be that safety representative.

Mr. WALKER. But yet—I would be glad to yield in just a moment. But yet in, for instance, John Young's memo, I assume that, for example, John would not regard himself as an engineer who is absolutely competent in all aspects of the seal, but he indicated at that point that there were some concerns about the seal.

What I am suggesting is that shouldn't there be somebody who would be raising those concerns in an appropriate time within each mission model?

Mr. WEITZ. Yes, sir, we have now gone full circle. I agree wholeheartedly with you on that.

Mr. WALKER. OK. All right.

Mr. NELSON. And that might be the point, whereas Mr. Weitz is suggesting that it might not be wise or they could afford the as-

signment of a particular billet, as he says, to this safety officer. Could you consider that when a crew is assigned to a specific flight that there be another astronaut that is assigned as a safety officer vis-a-vis that flight?

I don't expect you to give a final answer, but I throw that out on the table for discussion and consideration. Any first impressions on that?

Mr. WEITZ. Well, as a matter fact, we have taken a first step in that direction, as John mentioned both in his written and in his oral statement the fact that we now have Henry Hartsfield, an experienced astronaut, who is head of a newly formed safety office within the astronaut office and he has three people who are working for him in the various aspects of every phase of our operation, including airplane flight which includes not only the orbiter, but the entire STS and the payloads implications on safety as well.

Mr. NELSON. Just to clarify, earlier, however, you were speaking about something totally separate and independent——

Mr. WEITZ. Yes.

Mr. NELSON [continuing]. In an independent flight safety office within NASA that would report directly to the Administrator.

Mr. WEITZ. Yes, sir.

Mr. NELSON. All right, now where do you think such an office ought to be placed?

Mr. WEITZ. Physically?

Mr. NELSON. Physically and functionally. What should be its functions and what should be its authority?

Mr. WEITZ. Well, I have never been a safety officer. I haven't been to safety officer school, and we have lots of folks——

Mr. NELSON. I know. Neither have we.

Mr. WEITZ [continuing]. Who are more qualified than I.

You have to have resident offices at every facility that serves the shuttle. Now, in the past we have had that and I don't know why this system didn't work. I guess my only objection with the system as I see it now is that it did not report directly to the Administrator. Perhaps it is the Associate Administrator for space flight, rather than the Administrator of NASA. But the safety organization must have a presence at every component facility that serves the program.

Mr. NELSON. What do you think about in the chief engineer's office?

Mr. WEITZ. I don't know.

Mr. NELSON. I would like for Mr. Young to answer that because he had an interesting smile there.

Mr. YOUNG. Well, I don't know either, except that I think the head of the organization—if you are going to run a program where you are going to fly so many flights every year, and it is not just based on previous successful programs like that, there sort of needs to be a line organization with the straight lines of authority, and I think the person that is in charge of safety should report directly to the person who is responsible for it, because the person who is responsible for it has to make the decision of how many flights they fly, and that may be directly against safety in some times. He has to know how much it is going to cost. That may be against safety.

It is not any different than happens in every flying organization. There has to be a situation there where people can look at the total system and make the right decisions, and if it is a line organization to operate the vehicle successfully, I think that is the way that you would like to end up going ideally.

At NASA I think that is the way we should do it if we are going to be successful in operating the space shuttle, too, but like I say I don't think much of organization charts and who works for who. If you have the right people, it doesn't make a lot of difference.

Mr. WEITZ. Let me state, if I might, Mr. Chairman, that I hesitated on your answer because we don't want to build an octopus that strangles the program. It has to be functional, and therefore we would like to—and these are a lot easier to say than to accomplish, that you would like a lean and mean safety organization.

In retrospect, you gave me a breather while John was talking. I think it would be essential to have a safety representative in the chief engineer's office.

Mr. NELSON. Before I get to you, Admiral, let me ask Mr. Crippen, now do you have a different perspective on this? Do you feel that this might be an organizational kind of strangle hold that wouldn't allow the decisionmaking process to operate efficiently?

Mr. CRIPPEN. No, not at all. I guess I am in agreement with having what I would call a parallel safety office that was specifically concerned about flight safety. We have a safety organization to date, and it has worked through our chief engineer. My perception is that most of those concerns are really what I would relate to as industrial safety more so than specifically looking at a mission and looking at it from operational standpoint and judging how safe it is.

I think that we can not have a large organization, but need people that are located at key places who can hear all concerns that might relate to flight safety and make sure those get to the top, so I think that is a viable thing to do. It is like anything else. I think Admiral Truly or somebody said it earlier, we can draw line organizations all day long, and it usually ends up being the people that are put in it that make it work independent of the way the lines are drawn. So I don't really have any strong desires to sit here today and try to tell you exactly how we should organize it, but I think it needs to be in place, and I think that we have that support throughout the agency right now to go off and make something like that work. So that is in the bucket. It is being worked.

Mr. NELSON. Now that is a point of departure, Admiral Truly. We are here with you to look to the future. We are here using your memo as the base from which to exercise our oversight and investigatory authority to help you make sure we are going to have flight safety for the future. Now what are your comments about this thought that has been injected in here in this discussion?

Mr. TRULY. Well, as a matter of fact, I think Crip just said what I was going to make an observation about to try to put it in another way to help you understand what I think is being said here.

Institutionally we have an SR&QA organization that is integral to safety within NASA, and it does report to the chief engineer. There is debate even today about numbers of quality assurance people and so forth, and I think there is going to need to be some

understanding of those numbers because, frankly, I think that organization in general has been effective. That is not to say that it perhaps maybe needs some changes or augmentation or whatever.

I think that what is being suggested by John and these guys, and I appreciate it very much, is there another kind of thing that they refer to as flight safety. In a flying squadron where you have a lot of men taking care of airplanes and pilots flying airplanes and routine operations every day, generally the squadron has a safety officer, and he generally makes a nuisance of himself by having the authority to look into anywhere he wants to, and he bugs the pilots if they're not carrying their survival knife, and he looks at weather.

The shuttle, when we get into flying a lot of flights, is in exactly that business except in a far different and more complex way. I think what is being suggested, or at least as I understand it, is that some sort of a flight safety organization might be conceived, and that is our job to conceive it and argue it out, and I think it is a very good point that we don't want to strangle the system with it. Whereas in a squadron, that junior officer who is a safety officer and is bugging everybody else to make sure they have got their survival gear, can go directly to the commanding officer of that squadron, but yet if you have an airplane accident, safety has to be pervasive to the crew in that airplane and to the guys on the line that take care of it.

Frankly, I think that after Apollo, the SR&QA organization that was set up is a good one, and I am sure that the chief engineer is going to be looking at it, and there is going to be a lot of people looking over his shoulder just as it is one of his responsibilities to look over ours. But as a part of that memo that I wrote, I said that we are going to look at our entire management organization and this is a part of it. How it will come out, I don't know. I think it would be a mistake to design it by committee or in this forum or whatever. It is going to take a lot of bright ideas to improve what we are going to do, but we are going to do it.

Precisely where the astronauts fit into the organization is to be determined. You heard a unanimous vote, I think, or at least that is what I heard and frankly I concur with it because for 14 years I saw the world from that office, and that is that the astronauts very much need an input, but that does not necessarily mean that they have to run the FRR, or have to run the L minus 1 review. As a part of this effort, we are going to have an organization. I imagine it will be different from what we had going into 51-L, but I think there are going to be a lot of similarities.

In some cases, as I said before, changing an organization doesn't necessarily solve problems. In some cases, reinstituting discipline in a good organization can change it from being a bad one back to being a good one. We just haven't faced up to that, but we will.

Mr. NELSON. I appreciate your comments. I just want to make sure that everybody here understands that by virtue of me having a rather extraordinary learning experience, I saw firsthand how Mr. Young would worry and fret over the concerns and the safety of the individuals, and, I, for one appreciate that characteristic as he has exemplified in his professional duties. I want you to know that.

Mr. Walker.

Mr. WALKER. Just one question to follow up on a statement that Admiral Truly just made. From your analysis thus far, would it be your judgment that you need essentially a management change, you need more discipline in the organization as it now exists or some of both?

Mr. TRULY. Some of both.

Mr. WALKER. So you think that there may have to be some management shifts along the lines that maybe we have been talking about, but in large part, it may be the case of reimposing discipline on the existing organization? Is that a fair characterization?

Mr. TRULY. That is my personal view, yes.

Mr. WALKER. Is that a part of what the team which Mr. Fletcher has just announced is going to be looking at the agency? Is that a part of what they are going to be doing as well, taking a look at those kind of questions?

Mr. TRULY. I think what undoubtedly will really happen is that we are going to have to get on with taking a look at the Shuttle Program Organization before General Philips will have his study complete. And I am delighted, incidentally, in this situation, because I think there will be interrelationships, and we can adjust. Organizations can change.

I think what I would like to do, frankly, is to let the Presidential Commission make its report so that we know their view of what we should do in the area of program management, get the ideas from Arnie and the background and experience of the work they have done, and set about with some specific direction in some specific areas like this one, an independent flight safety organization, and cause some people to go off and make some changes that then later in the year, based on the larger NASA organizational look that Philips is going to do for Dr. Fletcher, see if that needs to be reiterated.

In this case, we have the time to do that. I have put it off a bit, frankly, because of the immediacy of some of the early things, and I don't think we have lost a thing in putting it off. I think it is appropriate. I do want to get on with it because it is a hard job. Everybody thinks they know how to draw an organization on a little piece of paper, but we have been living with the Shuttle Program for several years, and I don't want to undo some good things that we have going for us.

Mr. WALKER. And one thing that just strikes me as being a cautionary note with the situation that you have just described is I don't think we want a situation where you make changes based upon what you now know and implement those only to have the Philips Commission come back and suggest other changes that then undoes what you have put in place. I mean we could run up the pole and down the pole so many times that what we do is lose a lot of the momentum that we need in order to get back to fly.

I see that becoming a legitimate concern. If we have enough people studying the organization and enough people making recommendations, ultimately you can study it to death and recommend it to death, too. I mean there is in fact a problem there that we have got to spend some time considering as well.

Mr. TRULY. That certainly is a concern, but let me give you a specific. We now have flight readiness reviews. Should we continue to have flight readiness reviews and should they be chaired by the people that chair them and attended by the people that attend them? That is a question, and I think the answer to that question is darn right we should continue to do that, but we might change the attendance at the meeting or we might require that they all be done face to face rather than on a telecon or something like that.

I think within the program we can deal with that, and I doubt that what Sam Philips would recommend would undo that kind of decision. On the other hand, there are other organizational decisions, for example, the way that the program is run, the Shuttle Program, the level 1, level 2, level 3, and the centers, you know, the Johnson Space Center, the Kennedy Space Center, the Marshall Space Center. That also will have an effect on the Shuttle Program, but that is at a macrolevel that is going to have to wait his study. So even though hypothetically I don't want to change things too many times either, I think we can strike a proper balance by keeping him informed early as to what we are doing, make some early decisions—certainly not too early, but some appropriate decisions and stop talking about this and set some new shuttle policies, whatever they may be, in place before too long.

However, I would like the opportunity for the Commission to report out and time for the system to reflect on that.

Mr. WALKER. Thank you, Mr. Chairman.

Mr. NELSON. One of the questions that we will be asking in this committee you have just raised, and we would be happy to have any ideas from you all as to whether or not we ought to have a system, and would it affect flight safety and efficiency and so forth, as was the case under Apollo in which there was no lead center concept, rather that it was operated out of headquarters, and would that cause the centers to cooperate more with each other as opposed to little baronial fiefdoms springing up that may or may not occur.

Do you have any ideas on that you want to share with us? I am talking about any of you.

Mr. TRULY. The only idea I would share is I think that it is a legitimate thing that Sam Philips is going to have to look at. My personal view is that we could make some changes and make program management more in line, but I think we can solve our flight safety concerns in the present organization or in any different organization.

We can instill in the system an increased awareness of flight safety which we already have because of the accident, and we can sure beef up our shuttle program organization to include flight safety at a lower level of organizational decision, I think.

Mr. NELSON. Well, that in part is an unfair question. We will take that up with the Administrator, but we will be taking that up.

All right, let's talk about flight safety and crew training. You have enough of it? Do you have enough money for it? Do you have enough facilities? Now on the scaled down version of flight rates, do you have enough simulators? With what you have, is that getting you to where you need to be in crew training?

Mr. YOUNG. That's a good question, too. When we were talking about the year 1986, we were talking about 15 flights a year. The shuttle mission simulator people, when we started out the year, said we would need to do—220 hours of simulator time a week, and we would only be able to get 160 hours of simulator time a week.

If we are going to look at those kinds of flight rates, we have to get crew training, and Don Puddy, the fellow who works in mission operations, has a system designed to do that. It means upgrading those trainers to make them more reliable. We have two simulators, and the airlines get 20 hours a day out of their simulators. We have a far different thing because we have different vehicles, different mission models, different loads. We have a flight software load that has to come in every time, on time, and it is a totally different process. But we certainly would need to look at making those training operations more efficient to up the flight rate because you are really critically interested, as you well know, in the crew working together and being trained as a team. That is critically important, and the only place you can do that is a good old simulator.

We have three shuttle training aircraft that we train in right now and two of them have high time structural components. You flew in one of them. It has a scatter factor of 4. That means they have reached the hours where people expect things to start failing on them, and we have had some secondary structures fail. We have to inspect them frequently, and sooner or later they are going to fail some parts that have to go down for mods. So we need another shuttle training aircraft, a fourth shuttle training aircraft.

To make those simulators more efficient, it is going to take some additional resources, and to get an ascent and entry trainer which will off load the shuttle mission simulator some and allow not crew training, but individual training to get basic background of the complexities of flying the good old space shuttle. For example, to go into orbit, which I am sure you know, there are 175 different procedures that most of the crews have to know by heart, not to mention all the abort modes and all the things that people have to learn to operate this vehicle successfully.

So crew training is a key issue, and we need to upgrade our facilities. We need another training aircraft to operate at reasonable flight rates now that we are starting to run into fatigue failures on our shuttle training airplanes.

Mr. NELSON. All right, I would like to ask our staff to follow up with Mr. Young on exactly that question that directly impacts the funding questions for NASA for the future, and it directly relates to the subject of this hearing, which is flight safety.

Mr. Aldrich, I was quite impressed as I saw you operate a meeting of where you were pushing the system to the limit to try to get an updated computer program for another TAL site on STS 61-C, and as it turned out, the next day rolled around. There was not that computer update.

Tell me what you know about updating those kind of computer programs, of being able to slip in additional information in the mission's computer program. It seems like that you had a rigidity there that once a program was set, it was very difficult to change even though you had considerable updated information. In this par-

ticular case, the question was you needed the data in there about another TAL site because the two TAL sites that were in there look like, as they ended up finally being, unacceptable weather conditions.

What do you know about that?

Mr. ALDRICH. Well, there are several aspects to updating the computer for TAL sites. One is simply to have the right locations and NAVAID parameters for the sites involved, and those either tend to exist in the software loads that we use generally or can easily be applied.

The situation with regard to adding a TAL site on 61-C had to do with a change in location not only with respect to the characteristics of the site itself, but an adjustment to the guidance profile of the ascent trajectory so that if it was selected, the vehicle would fly correctly during its powered flight to get there. That is more complicated to produce quickly and needs to be generated in the simulation math models that are used by the flight design community.

Once it is generated and tested and produces the parameters, then they must be put in the flight software and again tested to be sure they were correctly entered. We have the capabilities to do that kind of work, but particularly ones that deal with the guidance and control functions of the spacecraft need to be very carefully handled and tested and be assured that they are correct before we would want to load them. So, I think the process is rigorous and sound and we need to be sure that we don't try to circumvent it.

However, my real thrust with respect to TAL sites is that I think we have not done as rigorous a job as we should on providing the complete set of facilitated TAL sites across the Atlantic, both in the European continent and in Africa so that we have the best sites available. We have them readily available to select in our computer loads as we put them together in a standard way, and we provide all of the landing and navigation aids at each site that optimize it for use.

That is a campaign that I am continuing to pursue, and we have a number of actions underway to be sure that when we resume flight that we have a very solid and complete set of transatlantic and later transpacific abort sites to serve the shuttle aborts.

Mr. NELSON. Are you getting the cooperation from the State Department that you want?

Mr. ALDRICH. Yes, in fact we get excellent cooperation from the State Department. Prior to the 51-L mission we determined the need to have a site in Moroco, and it was provided very cooperatively on short notice and was completely ready to support the 51-L launch.

Mr. NELSON. Was that only for 51-L or was that for all future flights?

Mr. ALDRICH. It treated a need that was specific for 51-L. However, it reflects the fact that we should have a more standard and broad-based characteristic set of sites, and it would be very applicable to many other launch trajectories on later flights.

Mr. NELSON. That is good to hear. Your weather is much better there most of the year around than the other sites; is it not?

Mr. ALDRICH. The problem was with the prevailing conditions at Dakar that are sort of weather related. There is a wind condition off the continent that blows dust and haze continuously for a number of days and weeks at a time, and that condition is not prevalent at the Casablanca site that we brought on board for 51-L.

Mr. NELSON. And was the flight program updated so that Casablanca was a part of that profile?

Mr. ALDRICH. Yes, sir, it was. However, we would also want a more complete set of NAVAIDS and landing lights. We were not able to commit to it for night landing, for example, because we could not step to the full outfitting that would be desired.

Mr. NELSON. Did you have a crew on site at Casablanca?

Mr. ALDRICH. We had a crew on site at Casablanca, and we also had Karol Bobko fly over and inspect it for us to be sure we understood its characteristics and that we had accepted it in the correct way and understood that it would be what we need.

Mr. NELSON. Mr. Hall.

Mr.HALL. Thank you, Mr. Chairman. I don't particularly have any questions, and I understand the thrust here is basically on safety and making inquiries that have already adequately been made, and I am late arriving so I do not know what has been covered.

Let me just say that one of the things that I hear as I go around my district, which is the old Rayburn district in Texas. They lay advice, and I am looking for an answer for it, and Chairman Nelson has done a very good job of vaccinating me for the fourth shuttle. Their attitude, and I think these are things that you need to know and need to be said and need to be heard, is that, well, we had a shuttle and then we decided we needed the shuttle in the event that one shuttle had difficulty to go after them, and then we got a third one in the event the second one was disabled, and now with typical bureaucracy we have four.

Of course, that is not the facts, and I understand that and Chairman Nelson has done yeoman's service along that line, but I will study your testimony here today and do feel the right to call on you for additional advice to shore it up. I support the program totally and am extremely proud of everyone at that table and everyone that is associated with you.

Mr. Chairman, thank you. I will read the record as to what has been stated heretofore and not burden you with additional questions, but I thank you for your time.

Mr. NELSON. Well, you jump in any time.

Let me ask you on the question of flight safety about the hatch door. As I understand it, after the Apollo fire, the door was redesigned so that instead of swinging outward like an airline door does, that it swung inward, exactly the reverse—that it swung inward like an airline door and then it was redesigned for safety reasons so that it swung outward, and so to with the shuttle door.

I noticed a bit of—well, I guess the best way to put it in extreme caution when moving around that door handle, even though a little metal clip had been designed to put over it, realizing that if you flip that handle only a small portion of an inch, that thing would suddenly open with the pressure differential on orbit.

What do you all feel about that vis-a-vis flight safety? Let's talk to the three gentlemen who operate directly in that realm.

Mr. CRIPPEN. Well, obviously, if you have a door that swings in, then the pressure that you have inside the vehicle keeps it closed for you, and that is ideally what you would like if you just consider those particular aspects of it. There were many factors associated with the hatch design and I am not aware of all of them.

What you described is correct. You would also like a hatch that when you are on the ground is easy and quick to open. That makes the swing out design desirable, and that is what we have ended up with. We have come up with what we call a lock-lock device to ensure that while we are on orbit the handle does not get moved and that is why you saw probably a little anxiety amongst your fellow crew members if people were bouncing around the hatch and the handle and weren't aware of it.

With the lock-lock device all of us are satisfied that it is safe, and we just make sure that everybody on board understands its criticality so that nobody goes around and fools with it. That's all.

Mr. NELSON. Do the rest of you agree with that? And you, too, Admiral Truly.

Mr. YOUNG. That old door and I have been in a fight since 1972, I think an outward opening hatch on a spacecraft is very much like an inward opening hatch on a submarine.

Mr. NELSON. Well, your position is made intimately clear.

Mr. TRULY. I don't have anything to add to what Crippen says. There is no question that on orbit you have to have absolute certainty that the handle cannot be moved inadvertently, and you have to have absolute certainty that everybody on board, whether they are a payload specialist or the commander of the mission is critically aware of it.

Mr. WALKER. Can I raise some questions with regard to centaur?

Mr. NELSON. Yes.

Mr. WALKER. Primarily to the astronauts, as presently designed, as I understand it, the shuttle centaur has a single dump channel for both the liquid hydrogen and the liquid oxygen. In the case of a return to launch site in an abort mode, if a failure occurred on the shuttle they would have to land, as I understand it, with full tanks in the pay load bay. Is that a matter of safety concern?

Mr. WEITZ. John is much more conversant with centaur than I, but it is absolutely a safety concern. Not only is your landing weight increased significantly, but you now have hypergols or cryogenics back in the cargo bay.

Mr. WALKER. Well, is it an acceptable risk to fly such a system in a manned vehicle?

Mr. WEITZ. With the single dump valve? We think not.

Mr. WALKER. So, can I assume that you would probably favor modifying the centaur to provide for a redundant dump channel?

Mr. WEITZ. I would really prefer to refer to John because he has been in on more discussions than I have.

Mr. YOUNG. Congressman Walker, we looked at that extensively, and our engineering people tell us you would like to put in, parallel dump valves or a series of parallel dump valves so you have more redundance in that system. There is not enough room in the orbiter to do that, so you have an interesting trade here. It is typi-

cal of engineering tradeoffs, and it is a very difficult one to make because you have a system in which a single dump valve can spoil your whole day, and yet the thing that you ought to do, which is put in series of parallel dump valves, probably you can't do because there is not enough room, and I think that whole problem is going to be addressed in quite a bit more detail in the next several years. The decisions made, rightly or wrongly, to fly with what we have or to do major design changes or whatever has to be done.

Anytime you have to make an engineering decision and neither decision is worth a hoot, you know you have got a problem.

Mr. WALKER. Well, I assume that by ruining your whole day you mean that we could have a potential for a catastrophic loss of the entire crew and orbiter at that point.

Mr. YOUNG. That is correct.

Mr. WALKER. So that we really are talking about something which has the same kind of serious consequences as the bad seals on the SRB's.

Mr. YOUNG. That's very true.

Mr. WALKER. And so the question, then, becomes is that really an acceptable risk to fly such a system in a manned vehicle.

Mr. YOUNG. That certainly is the question.

Mr. NELSON. We are going to follow up on this in detail, and I think Mr. Young has said, you know, it is a question, and the question is you get out of everybody everything you can get out of here, and then we are going to follow it up with additional hearings.

Mr. WALKER. And I think that is obviously one that we should, but I mean it really is a very very serious question for flight safety, because I think in large part that what most Americans are concerned about now as we deal with these issues are precisely those things which can result in catastrophic loss of crew and vehicle, and it is really that kind of concern. There was not adequate concern about that particular aspect with the SRB's, and we do want to identify those areas where that is potentially the major problem.

This certainly appears to be one of those places where not only are there serious questions, but I think the entire public perception of what we do in getting back to flying status is wrapped up in how we deal with those questions. Thank you, Mr. Chairman.

Mr. NELSON. Mr. Andrews.

Mr. ANDREWS. Just one or two questions to follow up. I note while I was absent during the testimony today, you have talked about the astronaut input on launch or no launch. I am curious, and I don't think this was covered. On the date of the launch, what kind of role does the astronaut corps play? As I understand it, Captain Young flies the weather. I am curious—correct me if I am wrong, and I am curious what other activities take place on your part and what kind of immediate input do you have or would you have should you make a determination to not launch?

Mr. WEITZ. OK, I get this one.

We have a system whereby representatives from the Astronaut Office are integral parts of this system. As such, we do not presently have the capability to stand up and say in that capacity I say we don't launch right now. We have on every launch, at least in the past, we have had two cap coms in the control center in Houston.

Mr. NELSON. Two what?

Mr. WEITZ. Two capsule communicators, the folks who talk to the spacecraft during the flight. We have one or two senior astronauts that are usually present in the control center. We have a spacecraft analysis room referred to as SPAN, in which we have a watch. We man that 24 hours a day with representatives from the Astronaut Office.

One of the three of us are typically flying the weather airplane. Since John is the chief, he gets to do it more than the rest of us do. But basically what we are doing is making inputs into an in-place system which is designed to consider such inputs from all elements of the organization.

Mr. YOUNG. For example, the weather guy, he really doesn't say go or no go. He just tells them what the weather is, and the mission rules say whether you go or no go. And that is the way it should be.

Mr. NELSON. Would the gentleman yield?

Mr. ANDREWS. I surely would.

Mr. NELSON. There is a specific case I want to ask about, and it was brought up in your memo, Mr. Young, dealing with STS 51-I, which was last August. The question was not so much if there was a hole in the clouds over the launch pad, but the question was was there acceptable minimums of what the weather would be like in about 25 minutes after launch in case you had an RTLS.

What was the essence of your comment in your memo of which you cited six examples and that was one of uncertain—and I am quoting—"uncertain operational conditions or events which we routinely accept now in the Space Shuttle Program."

Mr. YOUNG. I was referring to the fact that on 51-I we launched through two decks of clouds, and the first deck of clouds had no rain coming out of it, so we were OK. And we went through the second deck of clouds that didn't have rain in it, if the second deck of clouds had had rain in it above 5,000 feet, it would have done severe damage to the tiles of the orbiter, and then on reentry it would have been a very bad thing. Then I was also referring to the return to landing site weather conditions which are 6 or 7 miles away. And we had thunderstorm off the end of the runway there that was raining light to moderate rain. If we had had to do an intact return to landing site abort—and that would have been the first one that we had ever done—that we would have also, at the very least, damaged the tiles, and at the worst, if they had run into real drag problems which the engineering people would like to assess in a wind tunnel right now, we might have been worse off than that.

Frankly, I would opt for being a little more conservative in flying in weather down at the good old cape because, as you know, there are plenty of good weather days to fly. The day before and the day after that launch were just absolutely beautiful. It just turned out that we got everybody all tanked up and ready to go in the bad weather where we didn't have to because two out of three were good.

Mr. ANDREWS. If I could regain my time, I think the chairman's example is a good one. You also mention in your memo on that particular flight that I assume when you got up there your feel was that you just couldn't anticipate what the rain severity might be.

Mr. YOUNG. That is very true. I think it is difficult, and the weather people have a lot of trouble with that, too. They are trying to predict what the weather is going to be in a dynamic situation. In a normal aircraft, you wouldn't worry about that, but you worry about it with a space shuttle because we are very intolerant to tile damage, and we don't want to get hit by lightning. So weather that wouldn't bother some people would bother us considerably.

We can wait for good weather. As a matter of fact, if we look at the launch probability statistics for the 30-year weather average down at the cape and make some of our launch decisions based on that, I think we will find out we have a higher probability of success and would not subject ourselves to so much worry about flying in weather. Even though I get to be the weather pilot, I am not interested in flying around in those things either.

Mr. ANDREWS. Well, the point of my questioning to all three of you, do the astronauts themselves have adequate input at that critical time? John, should you have felt like on that particular flight that there should not have been a go, are you three confident that you would have the authority or the input that your message back would be followed up? I mean some of that evaluation, I assume, is just your feel of the situation like your are suggesting here.

You can't put a feel on whether there is going to be a bad thunderstorm right after lift off, but should you get up there and your instincts tell you, and I assume that is one reason that you have this little procedure is to get somebody with your experience up there. If you had that sense, and your recommendation was not to lift off, was to wait for another day, are you confident that they would listen to you and follow up on your suggestion?

Mr. YOUNG. I don't think NASA should listen to instinct. I think we ought to do it on rational logic if we are going to be successful. One of the things that we have learned about weather since we have been flying out of the cape is, for example, we launched Karol Bobko's flight, 51-D, through clouds that went from 12,000 feet to 33,000 feet, and there were little bitty pin drop raindrops in there, and after I got back I was talking to the weather guys, and they said they couldn't tell when those little raindrops were going to turn to big raindrops.

So that tells me that although instinctively we were going by what the Rockwell people told us about, you know, no moisture, that was not the right thing to do instinctively and practically, too. After you have talked to the weather people, you find they can't predict what you are going to be flying through. You don't want to take a chance of hurting your orbiter real bad. So we are smarter now, and we won't do that again, I'm quite sure, but you learn the hard way.

I also found out that the weather radar, they told me, didn't pick up all the raindrops that were in clouds, which I thought was a terrible thing to find out after we launched this bunch through that first cloud deck in rain on 51-I.

Mr. ALDRICH. Mr. Andrews, I would like the opportunity to comment on this subject, because I am directly involved.

Mr. ANDREWS. Sure.

Mr. ALDRICH. I started doing this job in August of last year, and I was responsible for the final launch recommendation to Mr. Moore

for six flights prior to 51–L, and for some reason or other, we entered into a period of weather in Florida that was particularly cantankerous for us, whether it was the summer weather or the winter weather. We had a number of days, even though I think we have the best detailed mission rules that can be put together for both launch and for the return to launch site landings, if we require them, we had a number of days where the decision about the weather is acceptable was highly subjective and difficult to make even given the best weather forecasting and the most firm rules we could put together.

This is probably the closest area that the crewmen you are talking to have a direct input into the launch decision process, and while we do ask them to give us a hard go or no go from flying in their STA and evaluation the weather, it generally turns out to be the very best interpretation of the weather condition that can be made to us, and we can vary what they do. They can assess the approaches to the RTLS landing strip. They can fly through the clouds over the launch pad, or they can make assessments of rain clouds that are further off in one direction or another.

Some of the most difficult days I have had in my life have been on days we did and did not launch during that time period and in dealing directly with John Young and P.J. Weitz and trying to interpret our rules and their reports and come to the right conclusion on that day. It is clear to me that in the future we need to baseline some more conservative rules in this area, but it is an extremely complex and difficult thing to deal with, and one that the shuttle will have to pay a lot of note of in the future.

Mr. NELSON. Admiral Truly, we are dealing from your forward looking projection in your memo, and this of course is certainly one of the items that you have raised in which you say the weather forecasting capability will be reviewed and improved where possible to allow for the most accurate reporting, and also these questions about launch assessment and reassessment. Now we have an example where we have two different opinions within your agency under your responsibility as we look to the future as to a specific example in the past, 51–I. So we are going to be needing to visit with you more about how do you solve this in the future.

Mr. TRULY. I'm not sure that I understand what you mean about the two different views. Frankly, I believe that John and the crew guys and Arnie's objective to make the correct weather decision, are 100 percent in synch, and you have heard the difficulty of it. We obviously need, if we can, to invest in better weather prediction capability. I don't know whether that has been dealt with yet or what it will cost, but we need to do that.

We need conservative rules, but I think John is exactly right. You would like not to have to make judgment calls. You would like to have rules and be able to go out and measure the conditions and then get the go or no go based on that kind of analysis, but the subject of weather—it is complex walking outside this building and trying to figure out what Washington weather is, and I don't think I have ever been anywhere where it is more difficult to predict than down at the cape.

When I was down there we spent many an hour trying for STS flights or something, and 45 minutes later after looking at the

weather, it had changed. It is a difficult area, but I think both on the program management side and on the crew side, the objective is precisely the same, and that is to make sure that we have good rules, and those are the only times that we launch or land.

Mr. NELSON. Well, correct me if I am wrong, but I had understood Mr. Young to say, and I will just ask him, that under the conditions of 51-I you would not have launched.

Mr. YOUNG. No, I didn't say that. I said that under the mission rules that day we launched all right, and since there was no rain in the clouds, we launched through them. I am saying that from what I know now, I don't think we would have launched. What I know now, I think that was not the conservative, proper thing to do based on the fact that the radar people just told me they couldn't see precipitation in the rain clouds, and we certainly were reviewing the rain clouds before we made that launch.

I also think it would be helpful if the first return to landing site abort was to be very conservative in the weather around the cape area, and I think that is what will happen as a result of some of our in-house working groups back there in Houston. The first one of those that the program ever does is going to be very exciting. And we want to make sure that it ends up successfully.

Mr. NELSON. All right, thank you for clarifying that.

Let me ask you, other than what appears to be the problem on the SRB regarding Challenger, how confident are the three of you that there are not other fundamental design flaws?

Mr. WEITZ. I am not confident at all because we think we have identified some, and that is what Arnie described earlier as a process on his special PRCB's in these other activities. Perhaps you want to say more about it Arnie, but we have got these three or four different categories in which every element within NASA has identified what they see as problems or issues——

Mr. ALDRICH. I would like to say these things we feel require critical looks for first flight may not be, in fact, fundamental design flaws, at least in all cases, but rather areas where there is discomfort with the amount of safety margin, and we feel the safety margin should be enhanced to give us confidence. A design flaw is, I think, a more serious finding, and I am not sure that we are running across a large number of those.

We are running across things that we have accepted before, and in the light of new assessment, we say now is the time to strengthen these areas.

Mr. NELSON. Yes, Mr. Walker.

Mr. WALKER. In that sense of evaluation, is the shuttle centaur question that we raised a little while ago, is that a design flaw in your evaluation?

Mr. ALDRICH. I would like to address your earlier comment on centaur. We have been very concerned about the centaur system, particularly with respect to safety and particularly with respect to abort conditions where we have to bring it back in the orbiter. There were a number of design corrections that were in work by the centaur program during this last fall and winter leading to the potential launches of two planetary flights in May of this year. And we were not at all satisfied that we were going to achieve the

kind of design margin and comfort with those changes that we would have committed to those flights.

We had another review in February to reassess them. Since the accident, we have reassessed totally the centaur shuttle configuration and identified a number of other areas in addition to those already known that at the time one feels that kind of uneasiness about and wants to put on the table to be redesigned and in fact many of them are in work.

There is a class of change beyond looking at the systems and the components, however, that is also being studied, and that is the total mission abort profile and hazard and the results related thereto and how the vehicle can perform, where it can fail, and how those anomalies can be handled. We have a complete design assessment team in that specific area reviewing those conditions. What their findings will be, I think, are open yet in terms of the degree of comfort that will come out.

We also are looking at the pressure control of the two tanks. The two tanks in the centaur, the liquid oxygen and the liquid hydrogen, are separated by a single bulkhead, and the pressure control schemes for the ascent and for the aborts are elaborate and they are computer controlled, and some of them are worked in algorithm schemes as opposed to direct pressure sensing. That also is being reviewed in depth for comfort with the engineering team across both centers.

This relates to many changes that are potential to the stage. It relates to concerns that we may or may not arrive at comfort with, and these are going to be brought forward in detail both to myself, of which I have reviewed many of them already, and to Admiral Truly for a total assessment of the kind that you are suggesting. Specifically on each change, but the aggregate also do we feel comfortable with this centaur as an element to fly in the shuttle, and as you point out, the abort is probably the focus of the most level of concern.

Mr. WALKER. I'm not certain. Do we have—I'm not asking you so much as I am asking other people here, I guess, but maybe you, too. Do we have a list of the specific items that you are considering on shuttle and on centaur for redesign?

Mr. ALDRICH. I don't have one here with me today, but I certainly could provide them to you in a short turnaround. We have them in Houston.

Mr. WALKER. Yes, if you provide a detailed list on both where things are being considered for redesign for the committee, I think that would be very helpful for our records.

Mr. ALDRICH. For example, when you say both, one of the design changes that we are already moving out with to the orbiter is a way so that if we do land with some of the hydrogen propellants on board, there will be a safe way to vent those propellants. The earlier vent was located down near where the vertical tail comes out of the fuselage, and there were a number of concerns related to how that manifested itself in hazard to the vehicle, and we are, in fact, extending the vertical vent to the tip of the orbiter tail so it can vent clear of all personnel and all vehicle hardware.

That is one of many, and I will provide you with that list.

Mr. WALKER. I thank you. Thank you, Mr. Chairman.

Mr. NELSON. Admiral Truly, are you going to address in this memo, and could you give us an estimate of time of when you might be suggesting organizational and procedural changes in order to improve the flight anomaly resolution process?

Mr. TRULY. For today, other than what I said a while ago, and that is I think the appropriate thing to do is to let the commission give its report and let us digest its contents, I would suggest that when we do formalize the process by which we are going to change organization, I would be pleased to share it with you, because I see it to be done on a schedule. I guess that debate will go on over the next few months.

Mr. NELSON. We will continue to visit with you on that question.

Now, how about the question of quality control. We are going to start scratching at this next week on Wednesday. You want to give us some pointers as we get into this question of quality control?

Mr. TRULY. Well, let me make a couple of brief comments about it. The quality assurance and the reliability of the system is an integral part of the fabric of us being able to operate safely. It is absolutely crucial to us, and it is crucial that it is done right, and that we have a good program that is well understood. This has been a part of NASA since its beginnings, and a major look at it was made after the Apollo 204 fire, and it is still a major part of our program.

What I would suggest, though, that you do when you have your hearings, and I am sure that this will come up, is to make sure that everybody is working from the same data base on numbers, because like all these things, it is a complex subject. Quality assurance, as I understand it, is a joint NASA/industry objective just like the rest of our program is run, and so I think we ought to make sure the Congress and the public and we are working from the same set of facts in order to decide whether or not the quality assurance program that we have is the proper one, and if it is not, I can assure you that you will never find a supporter more vocal or vehement than I to get it the support that it needs.

I think, frankly, that the first thing that I would make sure of is that all of us that are interested in this are working from the same set of numbers and understanding of the makeup of that program.

Mr. NELSON. Mr. Aldrich, when you wrote your memo January the 14th, did you have any data at that point that you wrote your memo from the SRB's and the joints?

Mr. ALDRICH. I want to make sure I understand your question. I did not feel sensitive to a concern about the SRB's or the joints in that time period, nor was anything——

Mr. NELSON. And that is perfectly reasonable, and I understand that.

Now, looking back on it, was there a degradation of the O-rings on flight 61-C?

Mr. ALDRICH. I can't recall.

Mr. NELSON. Does anybody?

Mr. CRIPPEN. Arnie, if I may.

Mr. NELSON. Mr. Crippen.

Mr. CRIPPEN. There was erosion on the left-hand segment SRB by a small amount, yes.

Mr. NELSON. Was it something on the order of four one-thousandths?

Mr. CRIPPEN. It was small. I can't remember the exact number. It was somewhere in that ball park, which was not unusual when we go back and look at the previous flights. We had several of them with erosion on them.

What, off the top of your head, might be the reason that in the January of 1985 flight, you had the most degradation of the O-ring? And if I recall the temperature at launch was 53 degrees. The temperature at launch one year later on the STS 61-C was 51 degrees with less degradation of the O-ring. Do you have any idea of why that might be?

Mr. CRIPPEN. I'm not prepared to go into detail on that, but the temperature you quoted for 61-C is lower than what I remembered it ever being, but we can go back and get that for you.

Mr. NELSON. Well, there are many other factors, and of course we will be getting that from the commission as it comes. The question of roundness, that was my question also on the SRB segments on 61-C.

Mr. CRIPPEN. That's correct. There is more than just temperature involved.

Mr. NELSON. Admiral Truly, you want to venture to us at this point some suggestions on how you can improve the communications and coordination process within the agency?

Mr. TRULY. I guess my answer would be to do two things: one is to do this organizational assessment, make sure that the lines of authority are clear. I am a firm believer in authority and accountability. I think we ought to make sure that from top to bottom we relook at the organization, change it where we must or should, and make sure everybody understands it, and make it clear. So that would be the first thing.

The second is that where we leave the organization to be the same, but run into areas which would require increased attention to what I referred to discipline, for example, in the example I gave before, when you have a critical review, should you allow it to be done on the telecon, or should you do it face to face?

The review stays the same. The organization stays the same, but the discipline—maybe that is the wrong word. The rigor in which you do it, and beyond that I don't have any comment.

Mr. NELSON. Anybody else want to comment on that?

Dr. Byerly? Dr. Smith? Mr. Tate? Mr. Clement?

Well, gentlemen, it is almost 3 o'clock. We have kept you a long time, but we needed to start this dialog, and this is just the beginning. As we continue on this question of flight safety—of course, we are continuing on with our next panel here, but this today is just the beginning of the continuous oversight process that we will assure will be exercised, and you all have been most generous with your time. We appreciate it very much. You have been forthcoming. Your answers have been clear, and we appreciate it.

We are basically all in this boat together, and that is to get us back in the space launch business as soon as possible, as safely as possible. That's the goal for all of us. Thank you very much. Have a good day.

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Mr. NELSON. We will call up our next panel, please. We thank you for coming and I am sorry that it is so late in the day, but as you can see, there is a lot to talk about, a lot for us to be in process of learning, and that is why we have called you all, because indeed you are a panel of experts. You are an extraordinary body of talent, and that's why you hold the position that you do, so we want to learn from you.

So I will call on Mr. Brizendine, if you would start off, and we can proceed from there. We thank you for being with us.

STATEMENTS OF JOHN BRIZENDINE, CHAIRMAN, AEROSPACE SAFETY ADVISORY PANEL; NORMAN R. PARMET, AEROSPACE SAFETY ADVISORY PANEL; HERBERT GRIER, AEROSPACE SAFETY ADVISORY PANEL; SEYMOUR C. HIMMEL, AEROSPACE SAFETY ADVISORY PANEL; AND NORRIS J. KRONE, SAFETY ADVISORY PANEL

Mr. BRIZENDINE. Thank you, Mr. Chairman and other distinguished members of the subcommittee. I think my associates from the Aerospace Safety Advisory Panel are identified at the table. I will mention their names. Beginning on my left is Mr. Grier, Mr. Parmet, Dr. Himmel on my right, and Dr. Krone on my right. Also in our audience is our able Staff Director, Mr. Roth.

I will be very brief in our remarks, Mr. Chairman, to try to respect the manner in which you would like to conduct this hearing, to allow the maximum amount of time for response to your inquiries. There are a few matters which perhaps might be useful for us to mention.

You are aware, of course, that our annual reporting to the Congress, this year's report was completed prior to the 51-L accident, and thus did not address it. Out of regard for the unique circumstances, we have sort of rearranged our manner of reporting and tried to look into the matters that we have observed during the past year that might have bearing on the 51-L associated activities. We have also thought it might be well if we looked at the past years panel's observations as they might be useful to the team in exploring things affecting the overall safety of the program, and it might be useful in the future.

Of course, we have been looking at how the panel might be of value in returning to safe space flight as promptly and as safely as possible. I think a point of our report last year that is worth mentioning is that the panel did state it felt that safe and productive space flight could be achieved with the STS Program if the real state of the art of the system is understood and other limitations around it are recognized, and these are integrated into the program planning and scheduling.

We recounted the matter that the hardware is still developmental. It has not yet achieved the reliability that is desired for a long-term operational system, and in some cases the durability needs to be improved, in some cases performance. Most of these things are identified, but they are yet to be achieved. We noted that at the higher rates of launches, annual launch rates, additional facilities are needed for processing and maintenance of this operational fleet.

We know that in respect to the extraordinary efforts of the dedicated people on the program who process the launches, that, however dedicated they are they cannot compensate for shortfalls in the physical resources or shortfalls in planning and scheduling. The logistics system is an integral part of that. It is still evolving, and it is a long way from where the panel believes it needs to be for satisfactory STS programs, and we consider this to be a shortfall.

The budgetary allocations for the program in the future are critical from the standpoint of what is needed to operate the STS Program and the competition for funds between other programs and between centers. We need to do realistic planning, we believe, within the means of the actual funding whether that permits one launch a year or "x" launches a year. I think this is part of the overall safety approach, recognizing how much money you have to do a given job with, and then doing the job within the means of those funds.

I think the panel would like to address the subject of SRB's very briefly since we are supposed to be an oversight panel, and we are supposed to recognize the hazards of these things. We looked carefully at our own practices and procedures to see why we didn't recognize the O-ring issue, the field joint issue on the 51–L.

For whatever reason, we didn't recognize it. We had been exposed to the field joint discussions over the prior years, although in 1985 we had really focused our attention on the filament wound case because of its upcoming urgency and the soon planned launches at Vandenburgh. We did note and do note that none of the development testing, the qualification testing or the laboratory testing on these joints showed any problem or revealed the rotation or the O-ring problem of that joint. That came from feedback from the hardware during flight operations.

Mr. NELSON. You say you did notice that or you did not?

Mr. BRIZENDINE. None of those activities revealed an indication of a problem, and on the database that we received, there was on indication of a problem with the joint. The panel, as I said, has taken a hard look at its own practices and trying to be introspective ourselves to see that we do the best job we can of focusing on the real serious or potentially serious issues.

On the subject of the filament wound case, incidentally, we did recommend that it not be used until its strength margins and its dynamic characteristics are sorted out, and these are two separate issues from the field joint, although the field joint question will probably have to be applied to the filament wound case, as well.

But as we ponder the field joint issue, it leads to some thoughts that might be useful for the future. STS now has a 25-flight data bank, if you care to look at it that way. The hardware has been telling us something during those 25 flights. It has been giving us feedback. This further leads to the philosophy of management of operations that involve repetitive-use hardware of this operational fleet, if you will, and it is somewhat different from a single event type of operation in procedures and discipline. The outgrowth of that is that risk management takes on a new perspective, and you have a repetitive-use hardware operating fleet.

Having determined the critical failure modes and the operating margins of the system from designs, all this happens prior to first flight from design analysis testing, verification, you do everything that is humanly possible prior to first flight to determine these things, and you establish the red lines that will respect your margins. Then you go fly, and it is the feedback from the operational hardware, the flight results and from the maintenance programs that control the risk management issues and the repetitive-use process. I think there is a distinction there that would be helpful to recognize.

This means that every anomaly from every flight has to have a solution or a satisfactory fix or be satisfactorily understood and explained prior to the next flight, because the hardware is telling you what you really should be thinking about. It is not an analysis anymore, it is telling it like the real world really is.

Now, one may have to make hardware changes, software changes, process changes, interim fixes, or even hold up your flying for a while if you can't satisfactorily explain the anomalies from each and every flight, but you must deal with every known criticality, and I emphasize the word, "known" because there was a tendency to talk about safety and absolutes, and I don't know of any absolutes in safety.

The thing that you worry the most about may not bother you, and the thing that you haven't even thought about may bite you, so it is a matter of perspective in that sense. The next flight we believe will be essentially a test flight, and the launch should be within the experience base to the extent possible and practicable. Obviously, some SRB changes will be made.

The panel certainly endorses Admiral Truly's strategy in returning to safe space flight. I think the panel would urge a couple of things. One, I think launch pressure is going to be greater than we have ever seen before once we get back into the flight status, because the backlog is building up, and backlog is pressure. Second, return to flight, however, from what I heard this morning, an awful lot of changes are contemplated, and that starts to violate rule 1. You fly within your base experience.

Something has to hold constant. Something has to be your reference data. You can't change everything at once, so I just would urge caution and good judgment, which I am sure that Admiral Truly's team will use in accepting and allowing the extent of change prior to the next flight. Make all the changes one feels are needed, but phase them in so that you only have a manageable number of variables to deal with in making the risk assessment for the next flight.

In reviewing the critical item list, I think the panel would like to comment on that, and we know that a thorough review is in process. We urge that they be, themselves, critically reviewed to sort out those that demonstrate an operating margin. There are probably some real difficult ones involved. We call them "zingers," that really require risk management assessment probably every flight, but we believe there is a need to reduce the number of critical items on that list to a manageable number.

How do you manage nearly 1,000 category 1, 1-R items? I don't know. I don't know how you allow anything to fly with that many

real category 1 or 1-R items. So I think there is a semantics question about the identification of these things, and they really need to be sorted out so that the folks making the risk analysis have some less complex judgments to reach in making minimizing the risk.

Last, one point that we would make today is that we believe that coordination among and understanding by all those involved—this is NASA, DOD, the contractors, and we have included the Congress, on a continuing basis is essential to returning to space flight as promptly and safely as possible. We heartily endorse and recommend the solid open communications, and I think everything needs to be on the table, out in the open. Teamwork. There is a need to establish confidence between these various agencies that I mentioned, and I mention them on a macro level, yourselves, DOD and NASA and the contractors. Mutual confidence, I believe, will go a long way in helping reach these solutions the way we all want to see them.

That's all the prepared remarks I would make, and we would be happy to the best of our ability, address any questions that you may have, Mr. Chairman.

[The prepared statement of Mr. Brizendine follows:]

NASA
National Aeronautics and
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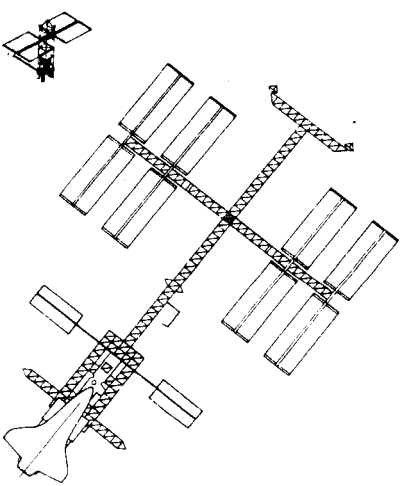
Presented by Witness
May 15, 1986

Subcommittee on Space Science and Applications

Committee on Science and Technology House of Representatives

Statement by:

Mr. John C. Brizendine
Chairman
Aerospace Safety Advisory Panel



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MAY 1, 1986

STATEMENT OF

JOHN C. BRIZENDINE

Chairman of the

Aerospace Safety Advisory Panel

before the

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

Mr. Chairman and Distinguished Members of the Subcommittee:

The Aerospace Safety Advisory Panel shares in the nation's grief over the loss of the Space Shuttle Challenger and its dedicated crew. As a result of that accident and the associated activities, the Panel has adjusted its agenda of planned activities to better serve NASA in reassessment of critical safety items of the Space Transportation System. The Panel's written report to you this year was completed prior to January 28, 1986 and covers our activities during calendar year 1985. Therefore it does not discuss the 51-L mission loss.

In consideration of the unique circumstances this year the Panel would like to present its report to this Subcommittee in three separate but mutually supporting parts:

I. Significant points made in our Annual Report dated January 1986 with emphasis on those potentially bearing on 51-L associated activities;

II. A revisit of points previously made by the Panel that may be applicable to the current introspective examination of the National Space Transportation System program; and

III. The Panel's projected activities regarding how it can support the vigorous efforts to safely fly once again, and to maintain its overview of other space and aeronautics activities such as the Space Station and NASA's Research

and Development aircraft projects.

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PART I

During calendar year 1985, the focus of Panel activities was directed toward the following:

1. The Space Transportation System's major flight and ground elements, mission rates, evolutionary changes in management, and operations at both Kennedy Space Center and Vandenberg Air Force Base;

2. The program definition phase of the Space Station and its current and projected management approach;

3. NASA aircraft operations, including the development of the forward-swept wing X-29 and the "X-Wing" Rotor Systems Research Aircraft; and

4. Special areas of interest, including the Shuttle/Centaur upper stages, Radioisotope Thermoelectric Generators used on planetary space vehicles, and Life Sciences applicable to manned space flight now and in the future.

The Panel conducted a total of 54 fact-finding sessions in addition to its appearances before congressional committees and its annual meeting with the NASA Administrator and his senior managers. The annual report delivered to NASA, the Congress, and the public contains substantial detail in support of the Panel's sixteen Findings and Recommendations; a listing of the Panel members, consultants and staff; and discussions of past and tentative future activities. As in previous annual reports, NASA'S response to last year's report is included.

SPACE TRANSPORTATION SYSTEM

The Space Transportation System performed in a highly credible manner during 1985. With an increasing launch frequency coupled with a number of organizational, operational, and key personnel changes, the government and industry program team demonstrated its ability to successfully contend with real-time anomalies in both hardware and plans. An outstanding example of this was the Leasat (or Syncom) salvage mission in mid-1985.

The annual report notes: ". . . that a safe and productive STS Program can be carried out if the System's real state-of-the-art and other limitations are recognized and integrated into the program planning and scheduling." In support of this thesis, five specific points are made; these are:

1. A number of the principal systems and components of the

Shuttle are in various stages of modification and improvement including the main engine, the general purpose computers, auxiliary power units, the brake and steering elements, launch pad improvements. These are to provide performance and reliability enhancement as well as accounting for the difficulty in obtaining spare parts for systems designed in the 1970's;

2. Meeting the increasing flight rate requires additional "brick and mortar" facilities at Kennedy Space Center for processing and maintenance;

3. Human resources applied to the various STS elements and the launch processing cannot fully compensate for shortfalls in physical resources; for example, spare parts shortages, frequent cannibalization for needed parts, immature component durability, and lengthy turnaround time for component repair/overhaul;

4. Logistics support, including sustaining engineering and maintenance plans, remains a current and future concern; and

5. The impact of budgetary allocations, and new and challenging programs such as the Space Station and the Transatmospheric Vehicle or Space Plane.

Those specific Findings and Recommendations we wish to note here are in some cases a follow-on to those found in previous annual reports and those which are, I will only mention briefly. Of those dealing with the Orbiter, structural capability and the brakes and nosewheel steering reinforce what has been stated previously. Two new points are made:

1. In order to provide 85% launch probability redlines, the structural modifications should be made to the wings on all orbiters. Redlines on orbiters 103 and 104 should be reexamined and changes made as required; and

2. Although we have been assured that no changes will be required in the applications software for the new, uprated general purpose computers, NASA must monitor this most carefully since applications software can be very expensive to change and retest.

Flight crew training continues to concern the Panel in that the unique Shuttle Orbiter flying qualities and the time-between-missions for the commander and pilot dictate the use of up-to-date, accurate simulators on the ground, and an adequately-sized fleet of Shuttle Training Aircraft to maintain the overall training syllabus. The Panel recommends that NASA commit the necessary funds to ensure that these requirements are met.

With regard to the Space Shuttle Main Engines, the Panel continues to support the Phase II program to improve the wear life of various critical turbopump components, the Phase II+ development of a new hot-gas manifold and the associated certification programs up to and including assurance that there is sufficient margin available when the engines are operated up to 109% of rated power levels. This includes the three-engine main propulsion tests scheduled in the near future. In addition the Panel recommends that the "precursor" or future program improvements be supported at a level such that they can in fact be incorporated into the flight engines as soon as possible. In the long run, such expenditures are usually cost effective. During 1985 the Panel's focus included the Solid Rocket Motor with the Filament Wound Case rather than the curently used steel case. With regard to the Panel's exposure to the STS 51-L most frequently mentioned probable cause, the "field joints": Panel fact-finding sessions over the past years have taken our members and consultants who are knowledgeable of propulsion systems to a number of sites dealing with the solid rocket motors; that is, Morton Thiokol Inc., Marshall Space Flight Center, Kennedy Space Center, and Hercules Aerospace Inc. The type of field joint used was discussed a number of times and no indication was given that the joint was a major concern based on the available data base. Development motor tests, qualification tests, laboratory tests and actual flight with the steel case, and the use of a similar design (with an added "capture" feature or "double clevis" to account for the far more flexible filament wound case) on the newer and lighter composite case provided assurance that there was an awareness of the joint and its capability to "do the job." With regard to the filament wound case the Panel's findings and recommendations noted: "The Panel wishes to note . . . the uncertainty of the structural strength of the Filament Wound Case for the Solid Rocket Boosters. Tests and analyses to date leave considerable question as to the strength margins of safety in the transition areas between case segments. Until the issue can be resolved with a high level of confidence, The Panel believes the Filament Wound Case solid rocket boosters should not be used for STS launch . . ."

Logistics and Launch Processing have been topics for discussion in a number of the Panel's prior reports and continue as major subjects of interest today. Three areas are covered here: the Vandenberg Air Force Base launch complex, the Kennedy Space Center, and their supporting logistics. From the human resources viewpoint the Shuttle Processing Contractor continues to struggle to handle the burden of work associated with each mission at KSC overlaid with the activities at VAFB. The past year has seen some progress in resolving these problems, but there remains much to be done. Actions which require continuous overtime on the part of technicians and engineers must be alleviated, and means of assuring that there are sufficient incoming qualified personnel to satisfy the demand for personnel replacements and changing technical demands are a must. Logistics is not just a "spares availability program," but goes far beyond that.

Logistics requires careful and thorough maintenance plans and procedures, skilled personnel assignments (e.g., sustaining engineering), "known" service life and reliability of hardware, awareness of manufacturers' abilities to continue to supply equipment as needed, and many other items. All of these are still in various stages of maturity and require nurturing by management with both attention and funding.

The Centaur vehicle, or Shuttle/Centaur, has been a continuing concern to the Panel. As we noted in this year's report: "The System should realize that the old philosophy that technical perfection is more important than schedule has changed with Galileo and Ulysses (missions). Management must now schedule with sufficient margin so that adequate technical performance can be obtained for fixed schedules. It is the difference between a development program and a transportation system. The case in point is that more than a few systems are to be verified or qualified as a result of the "wet countdown" on the pad. This simply does not allow any time for corrective measures should problems develop. Program management should prioritize the remaining work so that, if necessary, items essentially in the confirm for the record class can be waived." Since the postponement of the two Centaur missions, a number of Shuttle/Centaur replanning meetings have taken place. The object is to further reduce hazards and to make the most constructive use of the time before the new flight date. The Panel is pleased to see such activities since a reassessment is in itself a step that can only increase the safety of such missions.

The Space Station findings and recommendations were three in number. This is the time to implement basic philosophy into the program, before the Phase "B", System Definition and Preliminary Design, is complete. These recommendations are:

1. NASA should reexamine the resources required to conduct the many facets of the Space Station systems engineering and integration effort to ensure that the organization and human resources are sufficient to properly fill this role (at JSC), now and in the future;

2. NASA should determine possible means to alleviate the Orbiter payload bay interface environment design requirements which drive some of the Space Station elements and "user" designs; and

3. "Build-to-cost" management for the Space Station may involve many of the same or similar activities that confronted the Space Shuttle in its formative days. NASA should establish a small team composed of current and retired NASA/contractor persons who have first-hand knowledge of the early activities on the Shuttle Program. The team should define the "lessons learned" in both management and technical areas, including the real possibility of using today's technology to meet Space Station needs.

This covers applicable portions of our latest annual report.

Additional information expanding upon these comments is included in the annual report.

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Part II

In reviewing the Panel's previous years' comments, a number of items may be constructive during this period of re-examination by NASA and its contractors. Briefly these include:

1. (January 1985) " . . . recognition that the STS is a program still in transition from 'single event demonstration' stage to 'operational' stage, and will remain such until the full operational capabilities (and limitations) are known in quantitative terms based on scientific/engineering proofs; . . ." "recognition that complacency bred of repetition is an inborne human hazard and conscious steps to avoid same are essential; . . ." "the logistics system, at a minimum, must be supported by its current level of attention and funding."

2. (January 1984) "NASA make a concerted effort to assist contractors and subcontractor to produce the highest quality of product, oriented toward operational suitability . . . rather than increased performance as the dominant goal." "Excessive landing speed and control sensitivity result in: a continuing potential for a landing accident to occur; limitations on choice of abort sites; risk of destructive brake malfunctions; non-survivable open sea ditchings; lengthy and expensive training programs . . . a major reduction in landing velocity, and an improvement in the apparent stability (and consistency) in pitch control near the touch down point, would substantially improve the operational flexibility and safety potential for the Orbiter."

3. (January 1983) "The Panel recommends that extreme caution be used in decreasing structural factors of safety for weight purposes before all the pertinent flight variations are explored and all relevant data has been analyzed and taken into account." "As a first step, the management core of this operational organization should be established as soon as possible and given authority to resolve major management and budget issues that will inevitably arise among the development Centers as they support Shuttle testing and enhancement during the transition period. This core group would logically be situated at NASA Headquarters. This is another way of saying that someone at or near the top must clearly be in charge to control the natural competition among the Centers . . . ." ". . . NASA Headquarters institute a

review of the total certification process for Shuttle hardware as well as support functions such as software certification, ground support processes, maintenance monitoring, etc. It is further suggested that the policy for certification and the approval for deviation be a Headquarters responsibility."

4. (January 1982) "It would be advisable, therefore, to establish an "audit" team of experienced R&D systems-engineers to review the design of Shuttle systems to ascertain whether consistent safety/reliability concepts and criteria have been employed in the design. Where such consistency does not exist, the team should recommend design changes to provide such uniformity."

It is the Panel's suggestion that NASA and its contractors take the time to once again study the Panel's prior reports, their responses to them, and see if there are "lessons" to be learned that can be applied during this stand-down period and prior to defining those steps to be taken to ensure a safe and successful new "first" mission.

There are three areas of "Systems Management" that come to mind in meeting the stringent demands for ground and flight safety associated with extremely complex manned systems such as the Space Transportation System:

1. Systems integration which refers to the management functions which provide for systems engineering, technical integration, and test and ground operations. These management functions include the program level office for systems integration (Level II at JSC) and a large number of technical working panels (ad hoc and continuous);

2. Technical conscience which refers to those forums which provide people throughout the organization suitable opportunities to express their concerns to management. The Panel itself and the contractor and NASA Reviews are examples; and

3. Check and balance referring to the technical management capability outside of these day-to-day operations to provide independent assessments on key technical and management issues.

NASA has had and continues to have these qualities applied to the current Space Transportation System; however, with age they may have grown somewhat stale or perhaps too routine. If this in fact turns out to be the case, rather than conceiving a whole "new" structure it might be well to look into revitalizing and streamlining the current program/project structure and reporting lines. (This same thinking, of course, could well apply to the Space Station program).

Two other points should be made to reiterate the Panel's views with regard to funding: given program funding limitations, or constraints, the program should be scaled and planned to do a useful and constructive job within those limitations, and not pushed beyond; person-to-person communications are the basis of attaining and sustaining a safe and successful operation, and management's efforts must be concerned with this aspect of a program's life span just as they take into account cost, schedule and technical performance.

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Part III

The Panel believes that the following three major areas or activities must be considered in the planning and implementation necessary to return to safe space flight in a timely manner:

1. Minimum funding levels which allow a program to be constructed, consistent with a reasonable timetable, to accomplish hardware redesign and certification testing resulting from the STS 51-L accident investigation. Anything less would reduce both the level of safety and performance below that required to achieve a viable Space Transportation System;

2. The overall National Space Transportation System must be a mix of expendable launch vehicles and the Shuttle fleet; and

3. Coordination with and understanding by NASA, DOD, their contractors and the Congress on a continuing basis is required in returning to space flight as safely and quickly as practical.

More specifically, the Panel recommends that an internal or external group be established to gather and analyze the data necessary to establish the operational margins for the various Space Transportation System elements so as to allow better risk management. Thus the assessment of risks, identification of margins, and the subsequent operational controls needed to remain within the identified margins becomes an inherent part of the flight readiness and certification process.

In viewing the current situation the Panel has given consideration to several areas in tentatively defining its activities for the remainder of this year, and up to and including the initial launch following the reestablishment of flight schedules. These are:

1. The Panel's support for those organizations investigating and reviewing NASA and contractor activities to determine the required steps to get the National Space Transportation System back on track;

2. Examining the Panel's own practices and procedures to increase, where feasible, the Panel's insight into safety related items on the manned programs and the efficiency of the group as a whole; and

3. Maintenance of sufficient overview of programs other than the Space Transportation System to be effective in contributing to the overall safety programs such as the Space Station, Aeronautical R&D programs, payloads and their interfaces with the STS, and so on.

With regard to these three aspects of Panel operations over the coming months we have some suggestions, but look forward to the Subcommittee's comments in setting forth an agenda.

Panel reports have been forwarded to the Presidential Commission through the NASA focal points at both Headquarters and JSC. As Chairman of the Panel I had the opportunity to meet with Mr. Rogers and his executive director, Dr. Keel, after our own statutory public meeting with the NASA Acting Administrator on February 12, 1986.

In reviewing our own operations we have been looking at the Panel's information gathering, fact-finding process to see that it has been conceived and focused appropriately to reveal the important and critical issues affecting safety. The Panel is examining what should be done during the hiatus of the accident investigation, such as specific issues the Panel should emphasize to NASA. Other thoughts include:

1. Because changes to the Shuttle system are expected, the first post-STS 51-L flight will, in reality, constitute a test flight. Therefore, the Orbiter, flight crew, and Shuttle manifest should be configured to reflect the test nature of the flight, and that should be NASA flight Policy. This will also mean revised launch commit criteria, and so on, that must be factored into KSC operations;

2. Should there be an unmanned flight test of the Centaur? This is a cost/schedule/manned vs. unmanned evaluation?

3. As important as the flight details are, the ground processing operations at the KSC and VAFB must be viewed with a critical eye; beyond the review of procedures now used, are there documentation requirements (video-tapes, photographs, etc.) that can be used to sharpen the personnel and their approach to the launch processing?

4. Mandatory inspection points for all Shuttle elements have been reduced with time. Should these be reintroduced or another set up be used? Certainly an integrated maintenance plan is essential;

5. A major item brought up by the NASA Acting Administrator during the Panel's annual report meeting with him (February 12) was to look into the type and degree of instrumentation used in laboratory testing and on the ground and flight elements of the STS;

6. From a total agency and mission standpoint the critical single failure points in the ground processing and launch system are just as important as those for the flight hardware. These may require further detailed reviews; and

7. There are two major and complementary activities in the development of complex hardware. One is the production of the desired performance and the other the identification of uncertainties and the assessment of the associated risk. The two require different mental attitudes. At the operating levels, results are most objective and complete if carried out by different groups supporting and complementing each other. At decision making, the availability of two points of view of comparable competence, one focused on performance and the other on risk, is likely to prove of considerable value.

   In the field of risk management, the principle of developing systematically a branch for performance and one for risk is not limited to complex hardware programs. In this area NASA can make a major contribution by refining the process for complex hardware programs, thus providing a foundation on which to develop the management or risk for other areas. It can be useful in many areas of goverment and industry.

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Mr. Chairman, this completes my prepared statement. The Panel members and consultants present with me today would be pleased to respond to questions you and other Members of the Committee may have.

JOHN C. BRIZENDINE
Chairman, Aerospace Safety Advisory Panel

He completed 33 years with the Douglas Aircraft Company in May 1983 after trying his hand at teaching at the University of Kansas after college graduation. At the time of his retirement, Mr. Brizendine was President of the Douglas Aircraft Company, Inc. now as a part of the McDonnell Douglas Corporation and is located in Long Beach, California. His career included flight test work on a variety of high performance research and development, military and commercial aircraft. A partial list of these aircraft includes the C-124, SFD-1, D558-II (the first aircraft to exceed a speed of twice the speed of sound), X-3. A3D, C-133, DC-8. He was program manager of the DC-8 and DC-9 and program director on the DC-10. Mr. Brizendine held a number of executive positions including Assistant to the Vice President, Aircraft Division, then to Vice President of Engineering, Executive Vice President then as President of the Douglas Aircraft Company in 1973 until his retirement. He is a fellow of the AIAA. During World War II, he was a naval aviator.

HERBERT E. GRIER
(Consultant)

Mr. Grier was the first President of Edgerton, Germeshausen and Grier, Inc. (EG&G). He became involved in atomic weapons research for the Manhattan Engineering District and its successor, the Atomic Energy Commission. In 1953, he directed a group of EG&G scientists assigned by the Atomic Energy Commission to support its nuclear test operations. Since then the company has designed, built and operated the equipment that has armed, timed, fired, photographed and acquired performance data on almost every nuclear test blast in the Pacific and Nevada. They also provided instrumentation and photographic support for nuclear rocket tests.

Until his retirement in 1976, Mr. Grier was President of CER Geo-Nuclear Corporation, a company of which he was a founder, formed in 1965 by Continental Oil Company, EG&G, Inc., and several other companies. CER's principal endeavors have been concerned with the development and implementation of methods using the power of nuclear explosives in commercial applications, with primary emphasis on improving methods for the extraction of underground natural resources. Mr. Grier has numerous patents and publications in high speed lighting equipment and techniques, nuclear explosive design, timing and firing.

SEYMOUR C. HIMMEL
(Consultant)

Dr. Himmel was associated with NASA and its predecessor, the NACA, for 33 years. He joined the NACA's Lewis Flight Propulsion Laoratory in 1948 after teaching at the College of the City of New York. He was successively Chief of the Advanced Projects Branch in 1955 and the Mission Analysis Branch in 1958. He was named Manager in 1963.

In 1966 he was appointed Assistant Director for Launch Vehicle at Lewis; responsible for both the Agena and Centaur Projects. In 1970, Dr. Himmel's responsibilities were broadened when he was appointed Director of Rockets and Vehicles adding three research and technology divisions to the launch vehicle project offices under his direction and management. In 1972 he was assigned to NASA Headquarters for a tour of duty as Deputy Associate Administrator (Technology), Office of Aeronautics and Space Technology. Subsequently, he was appointed Associate Director for Flight Programs in which capacity he provided center-level oversight and management of all Lewis launch vehicle and spacecraft progams.

In 1976, Dr. Himmel was appointed Associate Director of the Lewis Center in which capacity he was responsible for the internal cooperation of the Center with emphasis on program development and long-range planning. In 1980, he was assigned the additional responsibility of Acting Director of Science and Technology. In this capacity he was responsible for creating a new directorate of some 450 professionals dedicated to research in the generic technical and scientific disciplines pertinent to aerospace and terrestrial propulsion and energy conversion systems. Having completed the orgaization of this directorate and establishing its programs, objectives and goals, Dr. Himmel retired from NASA in 1981. He is now engaged in consulting in his fields of expertise. He is an Associate Fellow of the AIAA.

DR. NORRIS KRONE, JR
(MEMBER)

Dr. Krone is the Executive Director of the University Research Foundation, University of Maryland. His past positions include Vice President for Special Projects BDM Corporation, McLean, Virginia; Office Director, Air Vehicles Technology Office, Defense Advanced Research Projects Agency, Washington, D.C.; Program Manager, Forward Swept Wing, X-Wing Defense Advanced Research Projects Agency, Washington, D.C.; Assistant to the CDR for Acquisition and Cost Analysis, Andrews Air Force Base, Maryland; Chief, Joint Services Action Group (JLC), Air Force Systems, Command, Andrews Air Force Base, Maryland; Manager of Advanced Development for Reconnaissance, HQ, USAF, Washington, D.C.; Technical Manager - Aeroelastic Programs, Chief of C-133Airframe Design Review, Aeronautical Systems Division, Wright Patterson Air Force Base, Ohio.

NORMAN R. PARMET
(Member)

Mr. Parmet was Vice President-Engineering and Quality Assurance with Trans World Airlines from January 1978 to June 1, 1981. He was responsible for the direct operation of three departments. (1)Engineering which has technical responsibility for the airlines operational fleet. (2) Technical Development which has technical and cotractual responsibility for the evaluation and construction of new aircraft types and their systems. (3) Quality Assurance which has overall responsibility to assure compliance of all technical standards set by engineering and the manufacturers.

From 1973 to 1978, he was Trans World Airlines Vice President for Materials Management and Vice President for Procurement. He directed the operation of the purchasing and stores department.

In 1971 through 1973, he was Vice President Quality Assurance, directing the operation of the Quality Assurance Department. This included overall responsibility to assure compliance with all technical standards of the airline. The department also provided field audits to guide shops and outside stations as to their performance compliance.

As Vice President for Equipment Development, from July 1962 to Septemer 1971, he directed the technical division of the planning and research major department.

From 1956 to July 1962, he was Director of Aircraft Development and a Power Plant Engineer from 1947 to 1953. He was supervisor power plant engineering from February 1953 to May 1956. Mr. Parmet served as a pilot in U.S. Army Air Force from 1943 to 1946 in command of the B-17 and B-29 aircraft. He is a Fellow of the American Institute of Aeronautics and Astronautics, and Member of Technical Board Society of Automotive Engineers and is the author of numerous technical papers many of which have been published by the AIAA, SAE,and ATA.

GILBERT L. ROTH
(Staff Director)

As Staff Director Mr. Roth, is directly responsible for both technical and administrative responsibilities asssociated with the Panel's total operations. Prior to his assignment with the Aerospace Safety Advisory Panel in 1971, he was Chief, Apollo Configuration Management and Executive Assistant to the Apollo Program Director at NASA Headquarters, and before that he was Head of the Performance Analysis Group within the Apollo program. He joined NASA in 1964, after 17 years of aerospace research, design and development work with General Electric Co., ConvairDivision of General Dynamics, North American/Rockwell, and other aerospace companies. He is the author of more than 35 papers on propulsion, heat transfer, fluid dynamics, instrumentation, program/project management and other technical disciplines. He is the recipient of numerous industrial and NASA awards.

Mr. NELSON. The critical items that you are talking about, category 1, if I recall, aren't there something like several hundred?

Mr. BRIZENDINE. I believe there are almost 900 or in that vicinity, somewhere under a 1,000, but it is a large number.

Mr. NELSON. Give us a basis of comparison. How many critical items would there be on an aircraft?

Mr. BRIZENDINE. I believe it is a matter of definition of what is a critical item. I wouldn't think more than a very few—by that I mean less than 10, perhaps, or five that I would call really critical issues that there isn't a margin for or a backup for or some kind of an operational margin that you can control that enables you to fly safely.

Mr. NELSON. And you raised the question how in the world are you ever going to fix all of these critical items, something less than 1,000 in the space shuttle.

Mr. BRIZENDINE. I cannot believe there are that many by my definition of a critical item.

Mr. NELSON. Well you all are one of the wisest panels assembled. Are you saying that there has got to be less critical items in order for us to be safe, or are you saying space flight is risky business, or are you saying both?

Mr. BRIZENDINE. All of that, yes.

Mr. NELSON. All of the above?

Mr. BRIZENDINE. All of them.

Mr. NELSON. Yes, sir, Dr. Krone.

Mr. KRONE. Yes, sir, I would like to make a comment relative to the aircraft question on a program that is sort of similar to the space shuttle problem that I happened to have participated in, in a key position.

Several years ago, there was some unexplained losses of the C-133, and this is a few years ago, about 20 years ago, as a matter of fact. There was seven losses, and no one had any idea of why the aircraft had—any of the seven had been lost. I won't go into the details. It is almost a Bermuda Triangle type situation.

The Air Force, at the time, organized a design review team, in which I was the airframe director, and we came up with 155 critical items that could be causing these accidents. This was starting from a base where we had no idea of what the cause was. In that one respect, we are kind of fortunate relative to the space shuttle problem.

What we did was we took some action on those 155 items. The exact reason for the accidents was never known, but after a review of the 155 items and some action taken, the aircraft was returned to service in about 6 months, incidentally, as I recall, and it served out its fleet usefulness successfully with no additional accidents. So that is the only comparison that I can think of.

Mr. NELSON. Does your advisory panel ever participate in any of the readiness reviews leading up to a space shuttle launch?

Mr. BRIZENDINE. The panel has in the past sat in on the flight readiness reviews as observers.

Mr. NELSON. You have sat in as observers. You have never participated.

Mr. BRIZENDINE. We are welcomed to participate if there is a comment to make in the open communications loop.

Mr. NELSON. Well, has there ever been a vote of a member of your panel in the question of go or no go?

Mr. BRIZENDINE. I am not aware of it. Perhaps Mr. Grier might have a comment.

Mr. GRIER. Yes, in the sense that the chairman of the review would go around the room and say to a contractor, "Are you ready to go." He would say to us, "Do you have any comments," and that sort of thing. Yes, we have voted in that sense, but not go, no go, simply as to the completeness of the presentation and agreement with the results.

Mr. NELSON. But that has not been every flight.

Mr. GRIER. No.

Mr. NELSON. Do you think that you ought to have participation every time as a voting member?

Mr. GRIER. No.

Mr. NELSON. You don't? Why?

Mr. GRIER. We just simply don't have the people nor the staff to get into the depth required to become a line voter really. I mean we are not line; we are staff.

Mr. NELSON. Do all of you agree with that? Everybody is nodding.

Mr. BRIZENDINE. We don't have the depth of attention to the day-to-day detail that are needed to make intelligent votes. If somebody came up with a specific question, we might be able to add a judgment to it.

Mr. NELSON. Mr. Walker.

Mr. WALKER. Is the shuttle centaur as presently designed safe to fly in a manned system?

Mr. BRIZENDINE. We don't think so.

Mr. WALKER. Do the redundancies requested by the crew make sense if they are going to fly that system?

Mr. BRIZENDINE. I am not personally familiar with what they all are, but I would say some redundancies are needed. There may be some solutions that are almost those for the "too-hard file", that is, too hard to solve.

Mr. WALKER. And if you can't make the modifications would we be wiser to go to ELV launches rather than flying in the shuttle?

Mr. BRIZENDINE. I think we would all sleep a little better, which doesn't mean that it isn't possible to do it safely in the shuttle. What we have seen to date, and I will have my colleagues comment if the wish. We are happy it isn't being launched this month.

Mr. WALKER. Anybody else have any comments?

Mr. GRIER. I think that you are tinkering with a very successful system. The shuttle centaur has had a great deal of success. I think as we make more and more changes to it to make it safer, you invalidate the historical record of its successes, and you better do very careful testing of that much changed system.

For instance, the Fairchild valve that is a single valve that is in the drain path, by the time you take four valves, but you have to now put them all different places because you have got space constraints. You have to put in the wiring harnesses and the systems and the redundant systems to run each valve, you don't have a Centaur anymore. You have got something else, and you can't look back and say there has been "*x*" number of successful flights of

that in the past. That is a danger. So you must be careful not to make too many changes or you just invalidate the history of what you are changing.

Mr. WALKER. Let me also ask you about the filament and wound boosters. As I understand it, your group has had some problems with that particular technology. You said that you have focused on it in 1985. Are you confident that there are changes being made in that system that will make it safe to fly, or do you continue to have those concerns?

Mr. BRIZENDINE. We are confident that competent expertise is being applied to the question. Assessment of the design, the testing to date and the suggestion of additional testing to be done, it remains to be seen whether the structure can be proven to have adequate strength margins or not with the current design.

Mr. WALKER. And the problem is in the strength of the system is your principal concern.

Mr. BRIZENDINE. That is correct. It is in the vicinity of the joint, we believe, but again it is not the field joint itself, but is the vicinity of the filament wound portion that is modified and cross-sectioned to enable it to be adapted to the next section.

Mr. WALKER. Yes, Dr. Himmel.

Mr. HIMMEL. In the junction between the filament wound and the composite material and the metal part of the joint, the issue of how the load is carried through that buildup is of concern and the testing program which has been stipulated for the proof of that is going to be the proof of the pudding because the analytical techniques available to treat that are not at the highest level of development. So you better rely on tests and more than one.

Mr. WALKER. It has been my understanding, and perhaps I am wrong, but it has been my understanding all the way along that in order to launch out of Vandenberg that that is a very important technology in terms of the system. I guess the question becomes should we be planning launches out of Vandenberg if we have not yet proven the strength of those cases?

Mr. BRIZENDINE. Well, the question is how much payload can you get out of Vandenberg.

Mr. WALKER. Well, yes, that's right.

Mr. BRIZENDINE. So the idea of the filament wound case is to save weight.

Mr. WALKER. Right. Precisely. But there is not much sense looking toward major launches out of Vandenberg that cannot meet the weight capacities because really that is part of the reason for launching out of Vandenberg.

Mr. BRIZENDINE. It is not a matter that has been determined yet.

Mr. WALKER. What about the 109 percent efficiency rating or 109 percent power rating that would be required? Have you taken any look at that, and are you in agreement that that can be done?

Mr. BRIZENDINE. We have taken quite a look at it, and of course it was going to be used first on the shuttle centaur.

Mr. WALKER. Right.

Mr. BRIZENDINE. It is also required out of Vandenberg, I believe.

I would like to ask Dr. Himmel if he would care to address that question.

Mr. HIMMEL. Yes. I think that it has to be put in this context, that there is a program called Phase II Improvement for the SSME which makes modifications to the turbine machinery and other parts of the engine system to increase the durability and the margin at 109. The engines have been operated at 109, but they have limited life at that condition to the point where in the current configuration, it is our position that you could probably, with reasonable comfort, fly an engine one time at 109 after running it through an acceptance test program, but then you would have to tear it down and examine it again and not reuse it. So basically you would be in a similar position to an expendable system.

The improvements that are being made and that are being developed by Rocketdyne have as their objective the increase of the margin. Our concern in that regard is that we truly demonstrate a margin sufficient so that we know where we are and how much we can tolerate. That is the critical program of testing which is in process and which recently, I gather, was interrupted by the discovery of a new phenomenon, some cracked blades, which has to be resolved.

Mr. WALKER. So it is your considered judgment that the 109 percent power rating would be acceptable if you were going to fly the engine once.

Mr. HIMMEL. Yes, with a lot of other provisos about pedigree of the hardware and things like that.

Mr. WALKER. OK, but then that takes us to another question that relates to this, then, because if in fact we are going to fly a number of flights in any given year where you can only use engines once, then you have to look at the backlog of engines that you have, the refitting of engines to orbiters, and your ability to do all of that within a safe scheduled time. Have you looked at that whole blend of sequences, and is there something that this committee ought to be aware of in terms of those kinds of problems?

Mr. HIMMEL. I think that it boils down to the same question of logistics that has been raised any number of times by other members of the panel. You have to blend that into your thinking, and you, at the same time, have to take steps to mitigate or ameliorate the situation with respect to the margin you have got. If the improvements work, then you will extend the number of flights which you will be able to use the engine at 109 or some mix of 104, 100, 109, and this requires a good sized data base with hardware which is identifiable and whose pedigrees you understand.

But it does come down, as you say, Mr. Walker, that you must also factor it into a logistical program.

Mr. WALKER. But the fact is we only have—the staff has just informed me—four spares for all three orbiters.

Mr. HIMMEL. Yes, sir.

Mr. WALKER. And I don't know what the timeframe would be for refitting an engine or recertifying an engine each time, but my guess is that if you are talking about a total tear-down and rebuild of the engine, you are talking about a considerable amount of time. It seems to me that has a very very significant impact on your flight schedule.

Mr. HIMMEL. You are talking about on the order of 6 to 9 months, I would guess, and here again it would take very careful planning, including only using 109 when you absolutely have to.

Mr. WALKER. So, if in fact we were going to use 109 percent on any given number of flights, as we look at our manifest, the fact is that we are probably going to have to fund the building of several additional spare engines. Is that a reasonable assumption?

Mr. BRIZENDINE. That and the improvement program. I think you are aware that the improvement program has been underway for some time.

Mr. WALKER. Absolutely.

Mr. BRIZENDINE. We are hoping to see three engines tested together in the fairly near future, and we believe that is essential before you fly at 109, because we don't know what the interaction is yet to be.

Mr. WALKER. Let me ask you of these figure jell with what you now know, because I think we are into an area here that can get somewhat serious if that is the kind of thing we are talking about. It takes four years to build a new engine? Is that approximately right, and the next three are going to go into the replacement orbiter would be the plan in order to meet the time deadline of building that orbiter within 3½-year period.

NASA spends about 3 man-years just to inspect an SSME after each flight?

Mr. BRIZENDINE. I don't know those numbers. Does anyone else? But 3 man-years might be reasonable. It is a complex machine and a lot of parts.

Mr. WALKER. So we really are talking about each time we fly at 109 percent, we are talking about a very severe limitation on the program. That is something we are really going to have to look at in terms of the flight safety issue.

Mr. BRIZENDINE. We recommend the full improvement program, some of which has been deferred because of funding availability, and we think in the long run, the full improvement program will save money because you will produce a more durable engine.

Mr. WALKER. Thank you

Mr. HIMMEL. I would just like to point out that I think that 3 man-year is probably tearing down three engines that will run at 109, completely tearing them down rather than flight to flight at 104. I don't think there is 3 man-years of effort in inspecting an engine that has flown at some other condition.

Mr. WALKER. OK, thank you.

Mr. NELSON. You gentlemen heard our previous conversation with the gentlemen from NASA about the independent safety office and the advisability thereof. May we have your comments about that?

Mr. BRIZENDINE. Yes, sir. The panel believes that the line organization, the system must be made to work, and adding an overlay, an independent safety office to those that are already in existence has some hazards. One is it tends to remove the responsibility from the line people for making the safety decisions, and obviously you don't want to do that. They must have both the authority and the responsibility.

We believe that a satisfactory safety result can be achieved without a number of overlying safety organizations, and we urge caution in getting too many of those.

Mr. NELSON. Well, that is very interesting because that certainly wasn't where the discussion was going this morning.

Mr. BRIZENDINE. They understood that, sir, which isn't to say that perhaps there shouldn't be an astronaut involved in the safety system. I think the subcommittee is aware, as the panel is, that the chief engineer's office of NASA headquarters has responsibility for safety, reliability and quality assurance, and there is a built-in means of focusing on safety issues that leads directly to the administrator, and it goes around every other organization and has, ostensibly, the clout and the wherewithall to go anywhere and everywhere to speak up anytime and wherever.

It is our thought that an astronaut assigned to that office would contribute to the thing that the astronauts are searching for. I don't mean permanently. An individual could be rotated, say, 6 months at a time or something like that, and it would be good experience and good training information for the astronaut, but it would give them a direct line into the chief engineer's office, the headquarters and into all the tentacles that they have through the centers and the programs related to safety reliability.

It should allow them to sense things early in the system as they are flushed up the system, as the technical conscience of the system works and the engineers and the technicians flush up concepts. We do believe that that would give a member of the astronaut corps a direct vote in the chief engineer's office. So in that sense, yes, but to add another independent group without doing something with some of the others or understanding how it is going to affect the line management—I wouldn't touch it with a 10-foot pole.

Mr. NELSON. Is your recommendation borne out of a different kind of experience that you have had in industry as opposed to some of the astronauts reflecting upon their military experience?

Mr. BRIZENDINE. Well, I don't think it is all that different. I think it is an assessment of how one executes his responsibility under his delegated authority, and if you start taking away the decision-making process from them, he is just going to hold up his hands and turn his back on his responsibility.

Mr. Parmet has been in this business. He would like to add something.

Mr. PARMET. As a member for a number of years for an operating organization, albeit much simpler devices called airplanes, I have some views on responsibilities for safety. No. 1, I believe you have to build safety into the product, so you have to inculcate this at the lowest level of the people building the device and make them responsible for the job they are doing. If they know someone is going to inspect their work, immediately they have less responsibility and they can fall back on the inspector.

From the top management standpoint, you must permeate your entire organization with that concept, and then QA becomes a functioning organization that examines the operating portion to see whether they have proper methods for doing the job and whether they live up to those methods, and then finally to audit

the output of their work. But once you do it 100 percent, you take away the responsibility from the people that are doing the job, and the overall technical responsibility for establishing what the work should be which should come from a technical organization.

The overall responsibility for the flying operation should be established by the operating organization. So you have a two-fold situation. To build it right, there has got to be this technical responsibility, and to operate it right, you have to have an operating organization, and the two teams should be working together. They should be built into the line organization and not have oversight controlling what they do. I think NASA has a chief engineer's organization that can do the technical oversight, and it certainly has an astronaut's organization that can oversee the operational part. End of comment.

Mr. BRIZENDINE. I believe the astronaut should be involved in signing off on each mission. I think it should begin months ahead of the mission when the mission plan is established, and the flight crew that is assigned and their office should be a part of the sign off. If they have done that, they will be involved, and as time proceeds to the mission any exceptions to that plan that are flushed up and reviewed and subject to further sign-off.

Mr. NELSON. Will you have an opportunity to be visiting with the NASA management on this subject?

Mr. BRIZENDINE. I believe so, yes, sir.

Mr. NELSON. Obviously, we would encourage you to bring your opposite opinion from what was expressed here by the earlier panel.

Mr. BRIZENDINE. I'm not sure we are all that opposite. Maybe we are only a few degrees off rather than 180.

Mr. NELSON. Are there any other organizational or procedural changes that you think ought to be brought about within NASA?

Mr. BRIZENDINE. That is a pretty tall order, a difficult question, Mr. Chairman.

Mr. NELSON. Sure.

Mr. BRIZENDINE. NASA's organization is very complex, and I think we recognize that. It probably can be streamlined, and I think we would like to have the opportunity to discuss it with the administrator—some views that we have on it.

Mr. NELSON. So you would prefer not to discuss that here?

Mr. BRIZENDINE. I think out of courtesy to the administrator, we really ought to lay them in his lap first.

Mr. NELSON. OK, once you lay them in his lap, will you come back and see us?

Mr. BRIZENDINE. We'd be happy to.

Mr. NELSON. Because we have got to oversee this whole thing.

Mr. BRIZENDINE. We understand, and I think the most honest reason for ducking the question today is we haven't sorted them out ourselves yet.

Mr. NELSON. OK, fair enough.

What do you think about the questions and the discussion that we had on crew training?

Mr. BRIZENDINE. We fully support the need for the crew training, and I think the successful landings demonstrated by the shuttle crew demonstrates the success of the training program. As you rec-

ognize, that is one of the three most critical phases of the flight, and particularly with the orbiter which doesn't exactly have the world's greatest flying qualities, so as a tribute to their training program and their discipline that they had performed superbly, we believe, in landing.

We also believe that the flight characteristics of the orbiter are not going to be forgiving of any shortchanging of the training syllabus, so if they need a new training airplane, buy it. If they need two, buy them. If they need another simulator, give it to them. I think a good syllabus has been established. We ought to live to that standard and not compromise it.

Mr. NELSON. What do you think about the flight rate projections?

Mr. BRIZENDINE. Well, they are aggressive?

Mr. NELSON. Optimistic?

Mr. BRIZENDINE. I think in general we would tend to say optimistic. We believe, I think, that you can probably handle a turnaround of, say, every 4 months for each orbiter, where we have a three-orbiter fleet. Ostensibly that would give you about nine flights a year after you have got things oiled-up pretty well. Probably with a mature system, that is, hardware, the people are experienced, the logistic system is in place, you could probably squeeze another orbiter per year. So maybe you could get 12 a year in 4 or 5 years from now out of a three-orbiter fleet.

Mr. NELSON. And with a four-orbiter fleet?

Mr. BRIZENDINE. Well, probably 12 to 15 growing to, perhaps, one more bird per year with the maturity that I was talking about.

Mr. Parmet, do you have any comment on that?

Mr. PARMET. I would agree with that general assessment. I would say that basically NASA's schedules have been optimistic, but I think they should be optimistic as long as they are not committed to a flight simply because it is put on a piece of paper, and they have to ascertain each time whether they can meet that. In the past, the original layout for the year has never been achieved, and we felt if things had gone smoothly this year, the numbers that John gave you were probably going to be the results, probably 12 flights this year if you hadn't had this accident.

Mr. NELSON. So with a four-orbiter fleet you are looking at 12 to 15 flights. You think that is it vis-a-vis safety?

Mr. BRIZENDINE. Well, again with the mature hardware and mature operating system, you might squeeze another bird per year with adequate logistics.

Mr. NELSON. What do you mean by squeeze another bird?

Mr. BRIZENDINE. You might get one more flight per orbiter per year, so that would add 4 to other 15.

Mr. NELSON. Instead of 12 to 15, 16 to 19.

Mr. BRIZENDINE. That's correct, sir.

Mr. NELSON. Any questions from the staff? Yes, Dr. Smith.

Mr. SMITH. Thank you, Mr. Chairman. I just wanted to ask one question related to the general area of risk analysis that the subcommittee has addressed before, and I just want to know from your perspective does it make sense for a quantitative risk analysis structure to be used in setting the overall safety goals or safety objectives for a particular launch.

Mr. BRIZENDINE. The data base is rather small for a quantitative analysis. I think most of us feel that if you did conjure up such an analysis, don't put absolute faith in it. Use it to bounce off your other judgments, as a guide, but the data base is just too small for a statistical analysis.

Mr. NELSON. Well, we are going to continue to want to visit with you over the course of time, and as our panel of wise men, we appreciate you coming and sharing with us.

Mr. CLEMENT. Mr. Grier, could I clarify one thing. You were discussing shuttle centaur and indicating that it was based on a great deal of experience with atlas centaur. Isn't it true that shuttle centaur is not in fact an exact replica of the atlas centaur and in fact is two entirely new spacecraft, shuttle centaur G and shuttle centaur G prime, which are both derivations but are entirely new spacecraft.

Mr. GRIER. That's correct, but a lot of the certification, if you will, goes back to its previous use and its previous successful history. For instance, the waiver—it must have to be a waiver to use a single valve in the vent line or the drain line. It goes back to the history of that valve in the single string centaur operation that it had over the years.

Mr. CLEMENT. And that operation was in an unmanned system where you did not have the considerations of the necessity of returning a manned vehicle during an abort mode.

Mr. GRIER. That's correct, but the further away you get the configuration of that valve from the old valve, the more fact there is to your statement that it is a new vehicle.

Mr. CLEMENT. Just as the Titan 34-D7 is an entirely new vehicle over the Titan 34-D.

Mr. GRIER. Right, and it probably requires more testing and more certification than—well, it certainly did than they could give it by this May, this month, and that is sort of behind our statement that we didn't want to see it fly this spring.

Mr. CLEMENT. I understand.

Mr. Chairman, I just wanted to establish that they are similar but not identical vehicles.

Mr. NELSON. Gentlemen, I thank you very much. I am down to 7 minutes to vote, so I am going to excuse myself, and instead of being able to thank you personally, I want you to know how much we appreciate this. We are going to look forward to a continuing dialogue on this subject, and I thank everyone for their time today. The meeting is adjourned.

[Whereupon, at 3:35 p.m., the subcommittee was adjourned subject to the call of the Chair.]

63-144 (125)