

National Aeronautics and
Space Administration
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Reply to Attn of:

Q-1

March 1, 2001

Memorandum for the Record

Pursuant to the provisions of the Federal Advisory Committee Act (Public Law 92-463, October 6, 1972) and NASA Policy Directive 1150.21, entitled "Establishment, Operation and Duration of NASA Advisory Committees," the enclosed minutes of the Aerospace Safety Advisory Panel's Annual Meeting are submitted for the record.

A handwritten signature in cursive script, appearing to read "David M. Lengyel".

David M. Lengyel
Executive Director
Aerospace Safety Advisory Panel

A handwritten signature in cursive script, appearing to read "Richard D. Blomberg".

Richard D. Blomberg
Chair
Aerospace Safety Advisory Panel

Aerospace Safety Advisory Panel
Annual Meeting
February 8, 2001
NASA Headquarters
Room 9H40, Program Review Center

Introduction:

Mr. Dave Lengyel, Executive Director of the ASAP, opened the meeting with greetings to Mr. Goldin, Dr. Mulville, and all attendees. He thanked Ms. Suzanne Hilding for an excellent turnover in the Aerospace Safety Advisory Panel (ASAP) Executive Director's position and turned over the floor to Mr. Richard Blomberg.

Mr. Richard Blomberg introduced new Consultants Sid Gutierrez former Shuttle Commander and the Honorable Bob Francis, former Vice Chairman of the National Transportation Safety Board. Mr. Blomberg thanked Suzanne Hilding for her excellent service as Executive Director, and the ASAP staff, Ms. Susan Burch and Vickie Smith, for their outstanding service to the Panel.

Mr. Blomberg reiterated that the Panel was formed by an act of Congress to review safety matters and to advise the NASA Administrator. The Panel has operated as an independent oversight body reporting to the Administrator and to Congress. The Panel generates it's own areas to examine as well as accepting requests from the Administrator for specific areas to examine.

Mr. Blomberg stated that the Panel was pleased that safety was placed in the forefront by NASA and it's contractors which has led the Panel to relatively few findings and recommendations in this year's report that are dealing with short-term, immediate concerns. The Panel did have one major long-term concern which deals with the current planning horizon for the Space Shuttle which the Panel believes is too short to allow the system to operate appropriately and safely.

Mr. Blomberg explained that in addition to the excellent safety focus by NASA and it's contractors, that the Panel was pleased with NASA's initiative to rebuild critical skills within NASA. The Panel believes that nothing is more important to safety than the availability of an appropriately skilled, experienced, and motivated workforce.

He stated that the Panel was very grateful for the help they received from NASA and it's contractors. There were no difficulties in accessing information or personnel during fact-finding trips for any subject that the Panel felt was appropriate.

Mr. Blomberg explained the operations of the Panel with regards to division into standing teams which address the major NASA areas such as Space Shuttle, International Space Station (ISS), and so on. The report is organized around the task teams/groups. In

addition, the Panel forms task groups for special studies/topics, which are not necessarily ongoing.

Mr. Blomberg then introduced the Space Shuttle Team Lead, VADM Bob Dunn.

Finding/Recommendation #1:

VADM Bob Dunn reiterated that the Space Shuttle Program has responded well to the challenges of the increased flight rate and recovering from an over ambitious workforce downsizing. The Panel does have some lingering concerns regarding aging equipment and infrastructure, quality of the work paper, the change in the workforce, and the ability of the existing logistics infrastructure to support for the anticipated life of the Shuttle. Nevertheless, the motto "Safety First, Schedule Second" is alive and well and that there have been several examples in the last year of the willingness to call a "time out" when such was called for. The overarching theme of this year's report is the current planning horizon for the Space Shuttle. VADM Dunn stated that the Panel feels that this horizon is not realistic and that what is needed is a clear statement of the horizon duration.

The Panel recognized the external agencies that have influence over this such as Office of Management and Budget, Congress, and various administration sources which make it difficult to establish a planning horizon that is realistic. If a realistic planning horizon is not adopted, several problems are created. The Shuttle is the only vehicle capable of servicing the Space Station, and servicing other spacecraft, which may need human attendance. At the same time there is no reasonable replacement in sight. There is not even a viable design currently available. The realities of funding and development suggest that a replacement is many years away. VADM Dunn offered the examples of the Department of Defense (DoD) and their experience with the F-22 and V-22 aircraft programs.

If NASA does not plan for a realistic Space Shuttle life span, it could compromise future ISS support and unduly influence other alternatives. In a short-term planning horizon, there is a perceived amortization issue and questions such as, "why spend money on an improvement if the Shuttle is going to go away shortly?" Therefore, the selection of upgrades and infrastructure repair are impacted and what might otherwise be safety issues are deferred. There are accelerating obsolescence and environmental issues that cannot be adequately addressed. The workforce will not have an assurance of a viable career path.

The Panel's recommendation is to extend the planning horizon to match a realistic design, development, and qualification schedule for a new human-rated vehicle.

Mr. Goldin responded that this is a very realistic and important recommendation and that we need to work with the new administration on what the vista is going to be for the Shuttle. Saying that, there are a couple of issues. If we only have a Shuttle without a threat of a new vehicle, the Shuttle Team might get complacent and think money is not an

object. On the other hand, as the Panel points out, if NASA says this new vehicle is coming soon and doesn't, and NASA can't spend money on the Shuttle, the existing vehicle (Shuttle) could become unsafe.. So we need to balance the two. The Administrator stated that there is a third problem, which he and Mr. Rothenberg have talked about, and this is the poor track record of the Shuttle program in estimating upgrade costs. Mr. Goldin asked that what Mr. Rothenberg needs to have ready for review by the ASAP, is not an all or nothing approach. One of the concepts may be to take a look at how Code S does their activity. They have a pre-Phase A which is generally done by the government. Then they go out for Phase A which is competitive and you let companies develop the concepts. Then you have Phase B where you go into more detailed proof of concept so that by the time you go to Phase C and D, you have what you want. What generally happens with the Shuttle is that a decision is made to do something, they move out to do it, and they haven't gone through that formality. And on the surface it looks like they'll get there faster but in reality it takes longer. Mr. Goldin thanked VADM Dunn for this recommendation and said that he would discuss this with the Administration prior to talking to Congress and get some definition and then get back to the Panel.

Mr. Goldin thinks that Code S has done a superb job at that. We've had a few problems but for the most part, it is the competition and peer review that causes people to be sharper and the preinvestment before commitment to final development allows us to work the bugs out. A good example of how they are doing that is the Next Generation Space Telescope. They are doing that very well and NASA is not committing to a final design until we get all of the work taken care of and in fact, as a percentage of the budget, they are spending more up front so they can spend less later money. Mr. Goldin stated that this culture needs to be integrated in the Shuttle.

Mr. Rothenberg responded affirmatively and stated that he thinks this would help this latest set of upgrades. He stated that NASA has both a short window to implement it and are running into trouble. Mr. Goldin requested that Mr. Rothenberg get back to him with a plan and a schedule. The Administrator will notify the Panel when VADM Dunn and his task force could come in and review it. Mr. Goldin asked for a plan and a process for how NASA will go do this--with follow-on discussion and some feedback. Mr. Rothenberg agreed.

VADM Dunn stated that the Panel has no prejudice or preconceived notion about the type of follow-on vehicle that is required. The Panel agrees that a replacement vehicle will eventually be needed but that it is not likely to be achievable in the timeframe available.

Finding/Recommendation #2:

VADM Dunn then introduced the second Shuttle finding to be presented by Mr. Sid Gutierrez. Mr. Gutierrez stated that the second recommendation flows from the first and that once NASA has accepted that the Shuttle will be flying for some time in the future, whether it be a decade and a half or two decades, a review is needed of its underlying assumptions. One of the basic assumptions that the Shuttle was built on was the assumption that the technology existed to build a spacecraft reliable and safe enough to

fly humans into space without an automated escape system. This has never been attempted with any other spacecraft, and the empirical evidence now says that that assumption was incorrect. The seven Challenger astronauts likely could have survived had there been partial pressure suits and ejection seats for them. The accepted reliability of the Space Shuttle and the minimum acceptable reliability for a human spacecraft as stated in NASA's Human Requirements documents differ by more than an order of magnitude.

Today NASA has an ongoing study, which has identified some escape system technologies that will help bridge this gap. In light of the expanded life of the Space Shuttle, an automated escape system should be carefully examined as a Space Shuttle upgrade. Mr. Goldin replied that he accepted the inputs and was aware of the ongoing study. What he doesn't want to do is have such a system degrade the reliability—have an apparent improvement in reliability and then degrade it. So this might be a good area to have a demonstration program along the lines of the concept talked about. NASA would like to improve the reliability of the Shuttle by an order of magnitude and improve the survivability for the astronauts by two orders of magnitude. This may be one of the approaches to getting at that. Mr. Goldin assigned Mr. Rothenberg the action of getting back to the Panel on this subject.

Finding/Recommendation #3:

VADM Dunn stated that the Panel's third finding has to do with the hydraulic system of the Orbiter. From what the Panel can determine, they do not seem to be adequately separated so that one mishap could sever all three lines. The Panel recommends that there be a degree of separation of these critical hydraulic lines. The question arises is the same thing true of wiring and the answer is that the Panel does not know at this point. The Panel will make that a topic of special interest during this coming year.

Mr. Rothenberg stated that the Panel was right on with this finding. As a result of last year's McDonald study, 78 functions were identified that include wiring that goes to a single connector or a single path. The same with hydraulics. NASA went back and looked at hydraulics, in fact, John Young had raised that internally, as did the McDonald committee. NASA is addressing both wiring and hydraulics, and there are already some changes in the system.

Mr. Goldin interjected to Mr. Rothenberg that on the list of things to be considered for future upgrades, other countries are looking at electromagnetics instead of hydraulics for actuation. We, NASA, have been the leader in the world in the field of electromagnetics in trying to get a more highly reliable system. We should at least be having some studies going on as to what would be the appropriate point in time to incorporate electromagnetics.

Finding/Recommendation #4:

VADM Dunn introduced the next few findings having to do with launch and landing to be covered by Mr. Richard Blomberg. Mr. Blomberg stated that the launch and landing operations at KSC are obviously safety critical for the operation of the Shuttle. The Panel has been examining those for several years. One particular issue deals with the work paper or work documentation. Dr. Himmel stated that last year the Panel remarked about their concerns with the state of the work paper and the procedures used to prepare the Shuttle for flight. These concerns included the quality, validity, accuracy, and clarity of these documents. Such deficiencies can lead to errors in implementation of the task as well as inefficiencies therein. In addition, there were a large number of engineering orders or changes that should have been incorporated into the applicable drawings and they were just tacked on making it very difficult and inefficient to use the drawings.

The Panel is pleased to report that NASA and United Space Alliance at the Cape, along with the element design centers and the element design contractors have devised and undertaken a well-planned, major effort to correct the situation. The effort involves reformatting, restructuring, and rewriting all the work paper that it takes to get the Shuttle off the pad. Commendably, the process involves all the people who are involved in the use of such paper including the technicians and the engineers who work day to day with the birds. Thus far, a significant number of procedures have been rewritten and converted to the new format and some have already been used operationally. The early results from this use have been gratifying. There are fewer mistakes and very little stoppage of work because of an ambiguity in the document. Much remains to be done. NASA had a 3-year projected effort to do this. The Panel believes the first year was pretty close to on schedule and they are continuing to work. The situation with respect to the engineering orders on the drawings is different. They are just getting started on doing that and the Panel will be observing this over the course of the year. The Panel does have one concern about the entire process and that is the rate of progress that can be achieved is highly dependent upon the availability of all these people who are part of the standard work force to accomplish all of these revisions. This involves the technicians and liaison engineers on the floor. With the increased launch rate in support of the ISS, the Panel is concerned that the effort that can be physically expended towards the revisions may be hampered. The Panel will be highly sensitive to this and will follow this activity in the coming year.

Mr. Rothenberg stated that NASA is tracking this issue very carefully. This is one of those areas where you can't add new people to do it. It will not do the job.

Mr. Goldin asked Mr. Rothenberg about his assessment of the increased launch rate and the impact on the drawing modification effort. He also asked if NASA was converting the drawings to a digital format and the plan to do so. He asked Mr. Rothenberg to look at DOD's B-52 and other legacy aircraft programs to see if they digitized their drawings. He pointed out that the B-52 is a five-decade program and the Shuttle is now a three-decade program. He stated that before we make upgrades to the Shuttle, that NASA might want to think about digitizing the database because NASA would be in a much better position to manipulate data and understand the impacts of upgrades. Even though

it may not add to the safety per se, it may be a higher priority. He suggested that NASA should have a broad-based study with DOD and Boeing (e.g. 737 aircraft) on legacy systems to gather insight.

Mr. Rothenberg stated that these items are tracked and reported directly to Mr. Mike McCully monthly. NASA is keeping pressure on the system to do it at the right rate. Since May of 2000 of the of the 6000 outstanding deviations have been incorporated in the drawings in the system, and the plan is to be down to 1500 by mid summer 2001. NASA asked Boeing/Palmdale to do a study of converting the drawings to a digital format last year and the price tag for this effort was high.

Finding/Recommendation #5:

Mr. Blomberg introduced the next finding which deals with KSC ground facilities. Plans for restoring and maintaining these vital assets are also lagging because they are not looking far enough ahead. The KSC personnel have done an excellent job in projecting the status of these assets and taking a look at the "bow wave" in problems and where they will be at future points in time. But as of yet there is no coherent program plan and budget to deal with the issues. What the Panel is recommending is that it is time to get at some of these things, especially the more critical ones. The likelihood of safety problems will increase with time not only because of single failures, but also because of multiple failures. These failures are difficult to analyze.

The Administrator stated that NASA has a problem at KSC in that they haven't had any new development in 25 years and that they are stale at this. The Administrator asked Mr. Rothenberg how we could do these projects a "chunk at a time" to allow KSC to develop these skills. He recommended Bob Sieck, of the ASAP, help with this effort in a ramp up, organized fashion.

Finding/Recommendation #6:

Mr. Blomberg introduced Dr. George Gleghorn to discuss the ISS issues. Dr. Gleghorn stated that the Panel did not have any major concerns with respect to the ISS Program but did have some specific technical issues. Since the Station is in an operational phase, the Panel would look into operational issues such as resupply, safety from a micrometeoroid impact standpoint, and shielding for the Service Module.

Mr. Goldin interjected and asked Mr. Rothenberg about the Service Module shielding issue and whether the schedule could be accelerated. He asked Mr. Rothenberg to take the ASAP input and go back to the Russians. Mr. Goldin asked the Panel to submit a letter [to the Administrator] stating that any delay in retrofitting the shielding is unacceptable and that we cannot allow money to endanger the lives of astronauts/cosmonauts. Mr. Rothenberg stated that there were schedule issues. The first

piece of this shielding is to fly during flight 7A this summer and the second flight has been pushed out due to funding problems.

Dr. Gleghorn discussed the issue of damage assessment and repair for situations which can affect ISS. For a number of years the Panel has brought up the issue of caution and warning (C&W), damage control and assessment. Dr. Gleghorn stated that an ISS team has been working on this for several years and that the job is moving forward but that the Panel has not had a chance to get up to date on exactly how far the team has progressed. Mr. Goldin discussed the letter that the ASAP sent regarding caution and warning, pressure sensors, and so on. The Administrator asked that Mr. Rothenberg and Dr. Gleghorn get together, focus in on this subject, and draft a jointly signed letter on this subject within a month or two months. He asked that the Chair of the Panel then bring this back to him so that NASA would have a set of actions to go work. This should be a broad set of tasks that the Panel requests that NASA perform, and the Panel would then monitor NASA against these tasks. Mr. Goldin said that the issue is more than just individual C&W devices, it is the failure modes and effects scenarios system-wide for worst case conditions.

Mr. Blomberg stated that there are some associated issues such that deal with, for example, the localization of a depressurization event and the use of hot-wire anemometers. The other issue is the larger end-to-end system definition issue. The Panel realizes that there are different groups working on this, MOD, engineering, and the Panel has not asked to hear the integrated story. The Panel will request a more end-to-end view in the upcoming year.

Dr. Gleghorn discussed finding number six, which is related to multi-element integrated testing (MEIT). The reports to the Panel are that the software for the Portable Computer System (PCS) has not kept up with this test schedule. Also, the final operational software is not available for testing until just before flight. As a result, this PCS software is only tested as part of the integrated system during regression testing. The Panel is glad that this is happening but hopes that more of the earlier MEIT testing could be done with the real flight software. This removes possible areas of ambiguity. Mr. Rothenberg discussed the software testing issues associated with setting up the MEIT program which had to do with trying to accelerate the back end software from those elements to be ready when the first element was ready, sometimes 2-3 years before they were planned. This was a very unnatural schedule so many things had to get prioritized. This will be a continuing struggle all the way up until the last element is launched to ISS. The regression testing is rigorous.

Mr. Blomberg stated that regression testing does not include as much crew time as the original MEIT testing and this is another potential source of concern. Mr. Goldin tasked Mr. Rothenberg, given the dilemma, to get the crews involved in regression testing.

Finding/Recommendation #7:

Mr. Blomberg introduced the Crew Return Vehicle (CRV) Team and Mr. Roger Schaufele. Mr. Schaufele stated that significant progress had been made in validating many of the technologies embodied in the X-38/CRV and its systems. The culmination of this technology validation effort is the launch of X-38 test vehicle 201 from the Shuttle in orbit next year. Nevertheless, the Panel finds that the specific definition of many of the tests identified in the draft of this space flight plan appears to be lagging. Since this return from orbit test is the final planned validation of the X-38, and the derived-CRV, every effort should be made to assure that the test is successful. The Panel recommends early completion of the X-38 space flight test plan so that sufficient time is available for a thorough review by all interested parties and incorporation of possible changes in the plan resulting from this review.

Mr. Goldin asked if Mr. Ken Szalai had come in to review the test plan. Mr. Rothenberg said that he had and had added many tests, which NASA is doing now. There are many tests to be done. The test plan had not fleshed out what the details of the objectives of each test are and how we are going to do them. Mr. Szalai has recommended a list of tests and NASA has accepted them and added them into the program. The test plan needs to be updated. They have a small team and they are not there yet.

Mr. Blomberg stated that the Panel was focusing on the specific space flight test because this is a one-off test. The other drop tests can be added very easily. So the issue is that there are a lot of "TBDs" in that space flight test plan. If they stay TBDs up until the end, there will not be enough time for people to assess them. This is a different problem from the overall test plan. The ground test plan is not an issue here.

Mr. Goldin stated that there are certain things that can be done on the orbital test but that it is the integration of the drop tests, the ground tests, orbital testing that is needed to be able to say that this vehicle is safe to fly. One of the reasons that Ken Szalai did this study is that the Administrator expressed concern that the program was testing nominal conditions and he wanted them to take a look all of the parameters and see how you could go around the nominal parameters and see that you do not have instabilities. The Administrator said that what NASA needs to have is an integrated set of the ground tests, the drop tests, and the space test with associated objectives to prove the system is safe and establish that the verification and qualification plan is adequate.

Finding/Recommendation #8:

Mr. Roger Schaufele discussed the next finding which deals with the X-38/CRV Program and the transitional phase to an aerospace contractor to produce the operational vehicle. During the technology validation program the NASA X-38 Team conducted many design studies, analyses, and specific tests related to safety issues of the vehicle and systems. In reviewing this program, the Panel finds that there is some possibility that all of the design knowledge related to safety issues that has been acquired by the NASA Team may not be transferred to the contractor team selected to build the CRV. The Panel recommends that

a comprehensive plan be developed to ensure all of the safety design experience gained by the NASA team during the technology validation effort is transferred to the contractor.

The Administrator stated that NASA personnel need to look at knowledge-based tools and benchmark how other organizations do development.

Finding/Recommendation #9:

Mr. Blomberg introduced the next area for findings, aerospace technology, and Dr. Norris Krone. Dr. Krone discussed finding number nine related to the operations of the Stratospheric Observatory for Infrared Astronomy (SOFIA) Program. The Panel's original concerns, dating back two to three years, related to the emphasis being placed on the redesign and modifications of the Boeing 747SP aircraft and the installation of the telescope. The Panel now feels quite comfortable with these issues. However, there was still concern having to do with flight operations once the aircraft was operational. Emphasis was therefore placed on understanding the avionics systems and the cockpit design. Dr. Krone stated that the Panel just recently visited with United Airlines and SOFIA program personnel to look into this, and the Panel feels very good about these issues as well. United is dedicating operations personnel to SOFIA, and there is a plan to upgrade the 747SP to the same level as other aircraft in the United Airlines fleet. The redesign and certification of the aircraft will follow all requirements from NASA, United Airlines and the Federal Aviation Administration.

Finding/Recommendation #10:

Dr. Krone introduced Mr. Robert Francis to discuss finding number 10. Mr. Francis stated that all of the major airlines have their Director of Safety or Vice President of Safety reporting to the top of the bureaucratic ladder. One of the issues seen at several of the centers was the director of aviation safety reporting through someone who had operational responsibilities. This is a built-in conflict. That is the Panel's concern and the root of this recommendation.

Mr. Francis went on to discuss the exposure that NASA has with 40-50 aircraft in terms of accidents and fatalities. In terms of having an accident or losing people, looking at the 30 years since the Shuttle, NASA may have lost more people in aviation.

Mr. Goldin asked Mr. Fred Gregory to look into this issue. Mr. Gregory stated that NASA has acknowledged this and agrees. NASA has just established an Aviation Safety Board where the Aviation Safety Officers (ASOs) can report through an independent path, which also allows any discussion of concerns that could have been blocked by work going on in the operations world. Mr. Gregory stated that the charter for this board has been written and he was meeting with the ASOs next month and this will be included as part of the response.

Mr. Goldin asked Mr. Gregory to include NASA statistics on injuries or deaths as part of NASA's response to this specific recommendation. He asked Mr. Gregory to get with the Center Directors to specifically resolve this issue and to benchmark the best in private industry and the military.

Mr. Francis recommended going to the Flight Safety Foundation web site for additional information.

Finding/Recommendation #11:

Mr. Blomberg introduced the cross-program area findings and Dr. John Stewart to cover the first area--workforce. Dr. Stewart acknowledged NASA's positive action with regard to termination of progressive downsizing goals to reach the employment targets set in 1995 as part of the Zero-Base Review. He stated that four years ago the Panel began to get evidence of workforce issues that were potentially affecting safety. Two years ago this was made the highlight of the ASAP's annual report.

Dr. Stewart stated that this human resources policy issue is now behind NASA and the challenge is now rebuilding NASA's human resources base and that this task is far from accomplished. Currently there is a hiring freeze in effect across the Executive Branch. The Panel assumes that this freeze will be relaxed in a reasonable timeframe. The problems of hiring, integrating, and training new employees into the workforce is the challenge addressed in this year's annual report.

Dr. Stewart also noted the clear call to action captured in the NASA Integrated Action Team (NIAT) Report, which was completed in September. The theme of this report--developing and supporting exceptional people and teams--was right on target. The Panel was delighted to see these recommendations and urges prompt implementation. The Panel views the recommendations this year as supporting workforce objectives that NASA is already pursuing.

Finding number 11 is to provide more effective incentives to retain employees with critical skills particularly in areas such as information technology and electronic engineering. Once the hiring freeze is lifted, the Panel recommends the continued recruitment of experienced fresh out employees using appropriate incentives.

Mr. Goldin paused for a moment to recognize Mr. Brian Keegan and his team who put the NIAT Report together. NASA did not go to outside experts; it was done with internal assets. The Administrator discussed a human resources case study at the Ames Research Center where a consulting firm was tasked with determining how to recruit talented engineers with financial incentives. He went on to say that the real incentive to work at NASA is the work environment and how NASA treats people because the Agency can never compete financially with the private sector.

Finding/Recommendation #12:

Dr. Stewart introduced finding number 12 related to the challenge of training and integrating new employees in any organization. The Centers are trying different approaches, some of which are quite good. The Panel applauds this. Some of the experienced people are unique in their knowledge of the elements of the Space Shuttle. When these people leave NASA, there should be a systematic process in place that captures their knowledge about their particular area. This information is so valuable that the Panel believes a formal effort should be made. The Panel's recommendations are related to mentoring activities, Agency-level training programs, hands-on training, systematic capture of knowledge, stress issues, and a systematic lessons learned effort.

Finding/Recommendation #13:

Dr. Stewart introduced Ms. Shirley McCarty who presented finding/recommendation number 13. Ms. McCarty stated that the downsizing and hiring limitations that have been prevalent over the past few years together with the aging workforce has created discontinuities in the normal career development patterns and this is further complicated by the lack of availability of scientists and engineers of the best and brightest quality. Ms. McCarty stated that this labor market is likely to get worse before it gets better.

Ms. McCarty stated that the Panel recommends that NASA develop a comprehensive, long-term workforce plan. The concern of the Panel is ensuring the continuity and availability of excellent leaders that will be needed in the future.

Mr. Richard Blomberg introduced the second crosscutting area of computer hardware and software.

Dr. Dick Volz mentioned that NASA has a number of activities underway which address previous concerns raised by the Panel. Rather than introduce findings of previous reports, Dr. Volz addressed several of the areas that had been covered previously including Shuttle avionics upgrades and the development issues with ISS software.

Mr. Goldin stated that he has been having e-mail exchanges with Capt. Bill Shepherd who really has a good understanding of the operational problems. The Administrator stated that the ISS Program has 10 times more software than any other NASA program and, if one looks at all of the distributed processing systems, NASA and its contractors have never done anything like this before. Based upon the issues and problems experienced in ISS, combined with some of the issues on the Mars programs, it became clear to NASA that not only NASA but also the private sector has a huge problem with high-reliability software. NASA has set up a high-reliability software consortium led by Carnegie-Mellon University on the grounds of the Ames Research Center. NASA has signed up every major software company and emerging software companies as part of this. The problem is that people look at the software development for the ISS in isolation

from understanding the degree of difficulty. NASA is on the cutting edge of these activities. We are going to try to build a base of support at Ames and in this country.

Dr. Volz stated that the Panel was pleased to see that sustaining engineering agreements have been established with all of the International Partners (IPs) for handling anomalies and engineering issues that may come up during the lifetime of the ISS. This did fall short of the Panel's recommendation of obtaining the source codes from the IPs but this may be largely due to proprietary agreements with the IPs and with their vendors. The Panel still suggests that NASA pursue this and find out how much it would cost to add that extra level of confidence.

The Personal Computer System (PCS) has taken on significant tasks in terms of the operation of the ISS. The Panel reviewed this and did not see any direct safety compromises, but there were some issues related to the user interface that the Panel is especially interested in. Dr. Volz reiterated that the Panel would like to take advantage of Capt. Bill Shepherd's operational experience on ISS with regards to this issue.

Mr. Goldin stated that one of Capt. Shepherd's major concerns is the user interface and the multiple user interfaces.

Dr. Volz stated that the CLCS is another issue that the Panel is following. There have been some major management and program changes in the CLCS this year. Rather than say anything right now, the Panel intends to look into how this program evolves in the coming year.

Mr. Goldin asked Mr. Rothenberg whether NASA had a focused plan for CLCS. Mr. Rothenberg affirmed that NASA has a focused effort and that NASA had brought in outside experience for program management. This team has made significant progress since being brought on board. NASA's contractor is now on the road to meeting the plan in front of NASA and this is widely accepted by both NASA and contractor personnel in the CLCS Program.

Dr. Volz continued on with a discussion of the Independent Verification and Validation (IV&V) Facility and the significant changes stemming from the organizational move from Ames to the Goddard Space Flight Center. The Panel believes that makes good sense. The Panel does have a couple of concerns and recommendations on IV&V. Dr. Volz asked Ms. Shirley McCarty to discuss these.

Findings/Recommendations #14 and 15:

Ms. McCarty stated that the Panel has long-supported IV&V for enhancing reliability of safety critical software. The refocusing of the Fairmont work to emphasize project activities rather than research has brought about some concerns. One is that with the increased emphasis for using IV&V, there needs to be a heightened awareness among managers and throughout organizations about the value of IV&V. The Panel believes

that a training program can facilitate the infusion of IV&V throughout the NASA. The second concern deals with the reorganization and the shift in emphasis to projects. The Panel is concerned that software research in general and IV&V research in particular will take a back seat. The Panel has seen some research at NASA but it appears to be fragmented. The Panel is especially concerned that sufficient research is done on how to validate advanced systems such as neural networks. There isn't adequate research in this area.

Mr. Goldin asked Dr. Dave Nelson, Deputy CIO, to comment on this finding. Dr. Nelson agreed that, in general, neural nets and other artificial intelligence agents do not have the discipline in terms of verification and validation that are used with more classical approaches to software. He stated that this is a research area. The Administrator asked Dr. Nelson to become more familiar with the research activities at Ames and that NASA needed to address this finding. He asked Mr. Holcomb and Mr. Venneri to answer this finding together with Dr. Harry McDonald and Mr. Al Diaz.

Mr. Blomberg stated that Ames realizes that they have the lead in this research area but the problem is that it is not yet integrated it into a coherent, peer-reviewed research program yet.

Finding/Recommendation #16:

Dr. Volz introduced the next finding dealing with computer security, which is not just a problem for NASA, but also for all of society. In some respects, the problems have become more difficult to deal with over the last few years. The hackers are starting to publish their tools and methods for doing this. While it is illegal to break into a system, it is not illegal to publish the methods to do it. NASA has put a lot of effort over the last two years to develop a computer security program. The Panel is pleased to see the things that have been done. There still is one issue in the annual report that does concern the Panel which deals with the development of security plans for all of the major computer installations within the Agency. This is one area that is lagging. These are typically assigned to System Administrators, and these personnel may be already overloaded. They sometimes have to deal with training across several different platforms. The Panel has two recommendations--to ensure that all of the plans do get completed and to train the people involved in this area and keep their training up to date.

Mr. Goldin asked Dr. Dave Nelson to comment. He stated that NASA agreed with the recommendation. The plans with one or two exceptions are now finished. Mr. Goldin asked that the plans be completed no later than thirty days from the meeting date.

Finding/Recommendation #17:

Dr. Volz asked Ms. Shirley McCarty to discuss the Panel's next finding and recommendation. Ms. McCarty stated that the Panel was enthusiastic about NASA's plan

to use the Software Engineering Institute's *Capability Maturity Model* (CMM). Although not a panacea, many software development problems can be avoided with best practices and continuous improvement processes that CMM level three and above can bring. The goal that NASA has set is no small one. The challenge is to make sure that NASA gets something for this commensurate with the effort that it takes.

Mr. Keegan explained that what NASA has done so far is to reinvigorate the software engineering working group. Mr. Goldin asked how NASA might get each of its Centers to come up to maturity level three and when NASA would have a plan in place to address these issues. Mr. Keegan stated that NASA was working on a set of milestones that could be tracked along the way but is still in the process of doing this. Mr. Goldin asked that the Panel take a look at the software engineering working group plan as a "reality check" before it is completed.

Finding/Recommendation #18:

Dr. Volz introduced the next finding and recommendation related to the computer system of the ISS. The issue is the loading on the Multiplexer-Demultiplexers (MDMs). The current system utilization limit for the central processor unit (CPU) has been set at 65 percent, and this is where they are at present. There are four major software deliveries to go which may add 5 percent utilization each. The ISS Program has been very clever at reprogramming things and they may have some success at this, but there is no assurance. Dr. Volz pointed out that his laptop computer is between 25 and 50 times more powerful than the computers on the ISS right now. In addition to the programming approaches, there has been an effort to look for replacements for the CPUs. The Panel urges that the plan for this not be put on the shelf but that this be vigorously pursued to provide some leeway.

Mr. Rothenberg stated that he agreed with this finding and that NASA has a Honeywell proposal that would take perhaps 24 to 30 months to go from the current design to a new one. This has been incorporated into NASA's latest budget request for ISS.

Mr. Goldin stated that this problem relates back to the "digital world." We had to build a space station so the design had to be frozen to do that. This is going to be a constant problem. NASA has some real issues to deal with that didn't even exist when NASA redesigned the space station. NASA signed an agreement last year with Intel. They are going to radiation harden a Pentium II processor and then take Pentium IVs.

Mr. Blomberg introduced VADM Kauderer to discuss EVA and radiation findings and recommendations.

Findings/Recommendations #19 and 20:

VADM Kauderer stated that following a long period of minimal activity due to delays in the assembly of the ISS, EVA rolled into high gear in year 2000. The successful outcome of these EVA events attests to the very fine detailed planning conducted by the EVA Project Office. Even though the Panel is pleased with EVA and its progress, there will be times in our future where we will enter into hostile environments where EVA will no longer be appropriate, so NASA should begin to look into robotics as the ultimate replacement for EVA.

Despite work in medical research programs and in various civilian and military nuclear energy programs, very little is known about the long-term effects of ionizing radiation. The Panel's recommendation is to accelerate the development of a neutron detector, both a personal dosimetry detector and an area detector, not only for current purpose but also for long-term development used in deep space.

The current Extravehicular Mobility Unit (EMU) is costly to maintain, is twenty-year-old obsolescent technology, and the inventory is short. There was an example of one being dropped and damaged which perturbed the entire logistics chain. The Panel recommends making the investment now for a new spacesuit.

Mr. Goldin stated that he asked for a report on ionizing radiation from the chief NASA doctor and a report on how fast NASA could get an individual neutron dosimeter. This is a serious problem.

Mr. Blomberg concluded the presentation of the Annual Report.

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