Statement of
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Before

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Committee on Science and Technology
U.S. House of Representatives

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Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to appear before you today. I will report to you on the observations and recommendations of the International Space Station Independent Safety Task Force.

As required by the National Aeronautics and Space Administration (NASA) Authorization Act of 2005 (Public law 109-155), the International Space Station Independent Safety Task Force (IISTF) was formed to assess vulnerabilities of the International Space Station (ISS) that could lead to its destruction, compromise the health of its crew, or necessitate its premature abandonment. The Task Force offered its recommendations in the form of its final report which was submitted to NASA and the United States Congress in February of 2007. The Task Force recommendations, if followed, should strengthen the ISS Program by increasing the likelihood of mission success and mitigating risks to crew safety or health. It is important to stress that, for these recommendations to be effective and for the ISS to remain a robust and healthy Program, sufficient support from the Administration and Congress is required to ensure that resources are provided and the safety-critical aspects of ISS assembly and operations are enabled and maintained.

The ISS Program is an international partnership comprised of the United States, Russia, Canada, the members of the European Space Agency, and Japan. Some 16 countries are in the partnership or involved via bilateral agreements with a Partner in building, operating, and using the ISS. This partnership will continue throughout the operational (post-assembly) phase of the Program, where NASA will continue to be responsible for the sustaining engineering, operation of NASA's elements, and integration of the Station.

The ISS is an extremely large and complex vehicle and at the time of the IISTF report had a current living volume of 15,000 cubic feet and a weight of 455,000 pounds. Planned assembly will expand it to 33,125 cubic feet and 855,000 pounds. Hardware and software are developed and tested all over the world and are assembled and operated on orbit at an altitude of approximately 215 nautical miles. Major systems including electrical power, cooling, data handling, and navigational control are distributed throughout the Station and are expanded as assembly progresses. Station assembly to date has gone exceptionally well and is a tribute to the ISS and Shuttle teams. Anomalies occur but are dealt with quickly and with outstanding results as demonstrated in December 2006 by the solar wing

retraction problem on ISS flight 12A.1/STS-116, where the spacewalking astronauts assisted in the retraction of the jammed solar array wing.

These factors result in a complex and distributed program with a highly technical and distributed management system that must be staffed by highly skilled engineers and skilled, experienced managers. Maintaining critical technical and management skills in the ISS Program as the ISS matures and NASA's exploration program staffs up will be a challenge requiring proactive and continuing attention by NASA management.

NASA depends heavily on U.S. contractors for technical support of Station integration and for vehicle operations. These contractors are the source of data and expertise that are critical in ensuring mission safety and success, and their timely participation is essential to meeting mission schedules. Due to the international nature of the ISS Program, this support requires mandatory interfaces with NASA's International Partners (IPs).

Currently the International Traffic in Arms Regulation (ITAR) restrictions and IP objections to signing what the IPs believe are redundant Technical Assistance Agreements are a threat to the safe and successful integration and operation of the Station. For example, a contractor workforce comprises a majority of the operations workforce and must be able to have a direct interface with the IP operations team to assure safe and successful operations. Their interactions and their ability to exchange and discuss technical data relevant to vehicle operations are severely hampered by the current ITAR restrictions. This is an issue across the ISS Program, but must be resolved soon to allow operations training for the first flight of the European Space Agency's Automated Transfer Vehicle (ATV) in the first part of 2008.

The ISS on-orbit vehicle is robust and, to the extent practicable, meets a two failure-tolerance requirement to minimize the likelihood of catastrophic events. The Russian and U.S. systems provide robust redundancy from dissimilar hardware and designs in critical systems such as guidance, navigation, and control; environmental control and life support; and crew/cargo transportation. For most safety-related issues, time is available to mitigate vulnerabilities by switching to redundant systems, performing maintenance/repairs by the crew, or relying on consumables reserves until a future logistics flight can be launched to the Station.

Time-critical exceptions to the failure tolerance requirements are uncontrolled fire, collision with micrometeoroid and orbital debris (MMOD) leading to a major loss of cabin pressure, toxic spills, or a collision with a visiting vehicle. However, the Task Force found that systems design, testing, and adherence to operational procedures either provide adequate controls or that adequate mitigations are being developed for these conditions. For example, the risk of MMOD penetrating the ISS in its Assembly Complete configuration is 55% with a 9% risk of a catastrophic result over a 10-year period. This risk can be reduced to 29% and 5% respectively by implementation of changes that are available or being considered for development. It must be recognized that regardless of the efforts put forth, operating in space is, and will be for the foreseeable future, inherently risky and requires continuing discipline and diligence to maintain safe operations.

The transition from the space Shuttle to post-Shuttle system(s) for logistical support to the ISS will require careful planning and phasing of new capabilities to ensure adequate logistics and spares are provided to maintain a viable Station. Approximately 160,000 pounds of logistics and spares must be transported to the Station between 2010 and 2015 by the Russian Progress or emerging transportation systems. The Program's IP's have committed to launch 40,000 pounds of this required 160,000-pound requirement. Premature commitment to emerging logistics delivery capability – if it does not materialize – could result in the loss of logistics support to the ISS for some time. Inadequate logistics will result in a serious decrease in the utility of the Station and could result in its abandonment.

The ISS Program has excellent processes and mechanisms in place on multiple fronts to ensure proper Program execution. A major component of avoiding catastrophic problems is continued diligence in monitoring the ISS system including hardware design, software development, flight preparation, and flight operations to detect and avoid unknown problems or inadequately defined operational environments. The ISS Program must maintain its current level of diligence throughout the life of the Station, never letting previous successes lead to a compromise in the required level of support or attention to detail.

NASA manages the health of ISS flight crews with intensive pre-flight medical screening, certification as "fit to fly," regular in-flight health monitoring, and a limited capability to diagnose and treat illness and injuries on board. In a worst-case scenario, a spontaneous health event may necessitate returning the crew to Earth for specialized medical attention, which would result in temporary abandonment of the ISS. Analogue environment data (i.e., Antarctica and submarine populations) and astronaut health events on the ground indicate that, with an ISS crew of six, the Program might expect a spontaneous medical event requiring medical evacuation once every four to six years.

Principal Observations

1. The International Space Station Program is currently a robust and sound program with respect to safety and crew health. Safety and crew health issues are well documented and acceptable, and are either currently adequately controlled or mitigations are being developed to maintain acceptable risk levels.
2. The International Space Station Program has strong and proactive crosscutting functions that – if continued – should provide advance indications and warnings that will avoid events that might lead to destruction of the Station, loss of the Station crew, abandonment of the Station, or development of untoward crew health issues. The International Space Station Program's operating procedures and processes are thorough and sound.
3. The International Space Station currently has an experienced, knowledgeable, and proactive team, both internally and in its institutional technical checks and balances, that provides the defense for process and management failures that might lead to an

ISS safety or major crew health issue. This posture must be maintained to continue the Station's successful operation.

4. Micrometeoroid and orbital debris penetrating the living quarters or damaging critical equipment is a high safety risk to the crew and the Station.
5. Spontaneous crew illness is a significant crew risk and may necessitate returning the crew to Earth for specialized medical attention, which would result in temporary abandonment of the Station. International Space Station medical and Program management officials are taking all reasonable precautions to minimize this risk.
6. There are significant programmatic risks associated with completing the ISS Shuttle manifest and providing robust post-Shuttle logistics capabilities that threaten the ability to support a viable Station.
7. Workforce composition is a growing concern throughout NASA because of the technical and specialized nature of most of the agency's work and the large-scale program transition now under way. The International Space Station Program is vulnerable to critical management losses, making strategic workforce planning as important as ever.
8. Design, development, and certification of the new Commercial Orbital Transportation System capability for ISS re-supply are just beginning. If similar to other new program development activities, it most likely will take much longer than expected and will cost more than anticipated.
9. The current International Traffic in Arms Regulation restrictions on NASA are a threat to the safe and successful integration and operations of the International Space Station.

Principal Recommendations

- The International Space Station Program should place the highest priority on options to decrease the risk of micrometeoroid and orbital debris.
- NASA should develop and implement plans to maintain Station critical skills and experienced managers.
- The Administration, Congress, and NASA should support the completion of the current Shuttle manifest to the International Space Station, including flights ULF-4 and ULF-5, to assemble a viable Station and provide spares for its long term operation.
- The Administration, Congress, and NASA should support a proactive and phased post-Shuttle logistical transportation program, including adequate funding of approximately one billion dollars per year above current allocations to ensure that adequate logistics and spares are available to maintain a viable Station.
- NASA senior management should conduct a comprehensive review of the Automated Transfer Vehicle to ensure agreement on the policies, approach, and technical implementation of the safety strategy for the Automated Transfer Vehicle's demonstration

- The Department of State should grant immediate relief from the International Traffic in Arms Regulation restrictions in the form of an exemption to allow NASA contractors direct interaction with the International Space Station's International Partners and their contractors. This must be affected no later than summer 2007 to support Automated Transfer Vehicle operations.
- The ISS Program should carefully consider implementing all IISTF recommendations to improve the overall safeguards and controls against vulnerabilities.

Further details on the principal recommendations as well as additional recommendations can be found in the body of the report "Final Report of the International Space Station Independent Safety Task Force".

It should be noted that NASA's support and responsiveness to the Task Force was excellent through the process of developing the data and material required to accomplish the charter of the ISSTF. The Program Manager and his team supported the technical review meetings and provided invaluable insight and technical data on the issues associated with the IISTF's charter.

With respect to the specific questions in the letter inviting me to testify at the House Committee on Science and Technology's Subcommittee on Space and Aeronautics the following is provided. My recommendations reflect the recommendations documented in the Task Force's report.

1. *What are the most significant findings and recommendations of the International Space Station Independent Safety Task Force*?

   The principal observations and recommendations discussed above are the most significant findings and recommendations.

2. *What was NASA's response to the Task Force's findings, and are there particular areas that you think require additional attention or action by NASA*?

   Per the NASA Authorization Act of 2005 (Public Law 109-155), the task force's charter expired in February, 2007. No further exchange between the NASA and the Task Force has occurred since that time. Since I am currently a private citizen, I do not have any personal insight into the status of NASA's response to these recommendations. For these reasons, I can not comment on NASA's response to the task force recommendations.

3. The Task Forces' report indicates that the risk of a "catastrophic result" from collision with micrometeoroid and orbital debris could be reduced to five percent over a 10-year period "by implementation of changes that are available or being considered for developed". Is NASA in fact implementing all the changes you reference, and if not,

would the resulting level of risk be acceptable to the Task Force? In any event, did the Task Force consider the five percent to be an acceptable level of risk?

Per the NASA Authorization Act of 2005 (Public Law 109-155), the task force's charter expired in February, 2007. No further exchange between the NASA and the Task Force has occurred since that time. Since I am currently a private citizen, I do not have any personal insight into the status of NASA's response to these recommendations. For these reasons, I can not comment on NASA's response to the task force recommendations

The ISS Program's requirement of '5 percent probability of no catastrophic penetration" was considered by the Task Force to be reasonable given the state-of-the-art in shielding design, the mass-to-orbit limitations and the state of the development and deployment of the ISS elements.

4. *The Task Force report discusses the risk associated with post Shuttle logistics capabilities to support the ISS. What would you recommend?*

I would develop and implement a fully integrated logistics support plan with off and on-ramps of available and planned capability for the logistics support for the Assembly Complete/six crew member/post-Shuttle era. The plan would include projected budget requirements for logistics support. I would recommend the Administration and the Congress support this plan.

I would not commit the ISS to an unproven logistics support system such as COTS. If a proven logistics support system is not available, I would commit to the future capability that is determined by engineering analysis to have the highest chance of success until emerging capabilities are proven

To ensure not being forced into dependency on an unproven capability I would procure additional spare proven capability to assure a smooth transition to unproven capabilities later and to minimize transition through down periods on logistics delivery systems.

I would develop an option that ensures that the two remaining Shuttle exterior logistics flights are given the highest priority for flight, in front of Node 3, if necessary, to avoid exacerbating a problem should all planned Shuttle flights not be completed.

5. *Why does the Task force consider the current International Traffic in Arms Regulations restrictions to be "a threat to safe and successful integration and operations of the International Space Station," and what would you recommend be done?*

NASA depends heavily on U.S. contractors for technical support for Station integration and for operations. These contractors are the source of data and expertise that is critical in meeting schedules and performing mandatory work with the IPs. For example, the

mission operations contractors comprise a majority of the operations workforce and must be able to have a direct interface with the IP operations teams to assure safe and successful operations. Currently the ITAR restrictions and the IPs' objections to signing technical assistance agreements are a threat to the safe and successful integration and operations of the Station.

Each U.S. contractor working with the European, Japanese, and Russian space agencies is required to apply for a Technical Assistance Agreement (TAA) from the State Department that governs their interactions with foreign entities for each specific relationship. U.S. aerospace and defense companies are accustomed to dealing with these TAA requirements in what has become a normal part of international business. However, when the Department of State approvals are too narrowly defined and come with many caveats, limitations, and provisos, they severely restrict Program management flexibility. The constraints imposed by the current processes result in lost time and opportunity to share critical data to enable a robust joint Program.

I would grant immediate relief in the form of an exemption to allow NASA contractors direct interaction with the IPs and their contractors to facilitate and accommodate all engineering and safety reviews, data exchanges pertaining to specific ATV/HTV hardware and software, Program management interactions, and flight operations including anomaly resolution.

Biographical Information for
TOMMY W. HOLLOWAY

Mr. Holloway retired in 2002 as Manager of the International Space Station Program for NASA's Johnson Space Center. Mr. Holloway was named Space Station manager in April 1999 after serving as manager of the Space Shuttle Program (SSP) for nearly four years. He began his career with NASA in 1963, planning activities for Gemini and Apollo flights. He was a Flight Director in Mission Control for early space Shuttle flights and became chief of that office in 1985. In 1989, he was named assistant director for the SSP for the Mission Operations Directorate. He served as Deputy Manager for Program Integration with the SSP and director of the Phase 1 program of Shuttle-*Mir* dockings before being named SSP Manager in August 1995. He served on the National Research Counsel Committee on Assessment of Options for Extending the Life of the Hubble Space Telescope (2004–2005). He received his B.S. in Mechanical Engineering from the University of Arkansas and has earned numerous honors and awards including Presidential Meritorious and Distinguished Ranks, the Robert R. Gilruth Award, and the Rotary National Space Trophy.