Statement of
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Mr. Chairman and Members of the Subcommittee:

Thank you for this opportunity to testify on the subject of Space Shuttle safety. There is no higher priority for NASA than the safe launch, operation and return of our Space Shuttle vehicles and their astronaut crews. The Space Shuttle represents assured human access to space for this Nation for at least the next decade, and is indispensable to the success and viability of the International Space Station (ISS).

NASA's space shuttle program has been one of the agency's real success stories over the last several years. The program, working with their contractors, has made significant reductions in operations costs -- by about a third even before accounting for inflation. At the same time as the operations costs have been coming down, the Space Shuttle has made dramatic improvements in the capabilities, operations and safety of the system. The payload-to-orbit performance of the Space Shuttle has been significantly improved -- by over 70 percent to the Space Station. The safety of the Space Shuttle has also been dramatically improved by reducing risk by more than a factor of five. In addition, the operability of the system has been significantly improved, with five minute launch windows -- which would not have been attempted a decade ago -- now becoming routine. This record of success is a testament to the quality and dedication of the Space Shuttle management team and workforce, both civil servants and contractors.

The fact that the Space Shuttle is the safest, most capable, and reliable space transportation system in the world is due, in large part, to the commitment of NASA, the White House, and the Congress to make the necessary improvements across the system to ensure safety and mission success. Let me assure you, however, that this has not been an easy task. It has taken exceptional leadership and an unfailing commitment to safety to navigate through a prolonged period of steadily decreasing budgets, although the last 2 years have seen increases in the Shuttle request. We have delayed needed investments in support equipment and infrastructure that today present themselves as significant management challenges.

We find ourselves searching for innovative methods to achieve additional operational efficiencies

while continuing to safely fly the Space Shuttle fleet through 2012. The truth is that most significant efficiencies have already been realized. Since submission of the President's FY 2002 budget request, the program has projected increased costs for Shuttle operations for FY 2002 and the outyears, some of which is driven by factors beyond the control of the Shuttle Program. These include contractor rate increases, core skill and business base erosion, supportability/obsolescence issues, and energy cost increases. Internal cost increases are largely driven by by the cost of orbiter operations support, such as critical re-wiring on the mature orbiter fleet.

In the following testimony, I will address the subjects of Space Shuttle upgrades, infrastructure revitalization and the Space Shuttle workforce as they relate to Space Shuttle safety in FY 2002 and beyond. I will also address NASA's FY 2002 Budget Plan for the Space Shuttle and associated challenges related to these same subjects.

The primary objective of safety upgrades to Space Shuttle systems is to achieve major reductions in the operational risks associated with those systems, and to provide safer Space Shuttle operations through system safety upgrades. NASA's FY 2002 budget request provides a large increase to the Space Shuttle safety allocation, from $256 million in FY 2001 to $406 million in FY 2002. The total Space Shuttle budget in FY 2002 and the out-years is flat, and does not provide for adjustments due to inflation in anticipation of achieving incremental operational efficiencies. NASA has been conducting an external review to assess how the Safety Allocation funds can most effectively be used to improve the safety of the Space Shuttle, to include investments in hardware/software upgrades, personnel, facilities, or other safety-related areas. NASA will proceed with investment activities once Authority To Proceed (ATP) has been accomplished. Space Shuttle safety investments are an important element of NASA's strategy for an Integrated Space Transportation Plan (ISTP).

Cost challenges to the Space Shuttle Program and upgrade technical issues are presenting significant potential impacts to increasing Space Shuttle safety. Some individual safety upgrade projects are being evaluated for cancellation or deferral in FY 2002, due to either technical issues or to pay for increased costs that were not known at the time of the FY 2002 budget submission. These issues will be addressed as we work with the Administration in formulation of our FY 2003 budget. In our deliberations we will try to avoid near-term decisions at the expense of improved safety (current risk) in order to preserve a safe and viable six flight rate per year core Space Shuttle program. We will also seek to address facilities and infrastructure requirements in the program.

Space Shuttle Upgrades and Program Achievements

The Space Shuttle is a very mature system, remarkably reliable, very mission flexible, and a true testbed -- not just for scientific inquiry, but also for forming international partnerships and goodwill. Wise investments in safety upgrades during the course of the program have kept the Space Shuttle viable and ready to meet the needs of our Nation's space program.

High Launch Rate Reliability -- Of 106 launch attempts, there have been 105 successful launches, equating to a launch reliability of greater than 0.99. Let me add to that, Mr. Chairman, that while we are proud of our accomplishments, anything less than 100 percent is still unacceptable in a human space flight program.

Mission Diversity -- The Space Shuttle has launched over 3 million pounds of cargo and over 600 humans from around the world. The Space Shuttle is the only launch system in the world that can deliver and return large payloads to and from orbit. Each Space Shuttle flight can support a diverse package of mission objectives. The Space Shuttle is very flexible in accommodating all types of missions, including those dealing with National security.

International Leadership -- No other country has been able to integrate the technical, operations management, and financial resources to develop its own human-rated RLV system. At least 38 percent of the Space Shuttle flights so far have carried non-U.S. astronauts. This percentage will increase as we continue to assemble and operate the International Space Station.

Invaluable RLV Operating Experience -- The Space Shuttle Program has provided over 20 years of invaluable experience in Reusable Launch Vehicle (RLV) Payload Integration and Flight and Ground Operations. It has produced a massive database of technical information from which future improvements will be made to next generation RLVs.

Privatization -- The Space Flight Operations Contract has proven to be successful in finding efficiencies and reducing cost. Lessons learned with this effort will ultimately pave the way for further privatization of the Space Shuttle that is envisioned under the President's Blueprint.

Space Shuttle Technology Spin-offs -- The trickle-down of benefits from the Space Shuttle Program continues to impact the development of new electronic devices, medicines, improved manufacturing procedures. The Space Shuttle Program in the U.S. private industry has created thousands of jobs.

Space Shuttle Upgrades Program - Objectives and Strategy

The Space Shuttle Upgrade program is intended as a proactive measure to keep the Space Shuttle flying safely and efficiently in support of the Agency's commitments and goals for human access to space. Shuttle Upgrades are intended to enhance the primary goals of the Space Shuttle Program:

Fly safely;
Meet the manifest;
Improve mission supportability; and,
Improve the system.

The two types of Space Shuttle upgrades are safety (high priority) and supportability. Safety upgrades are those upgrades that minimize ascent, descent, and critical operations risks. Supportability upgrades are those upgrades that maximize Flight Hardware Availability Assurance (FHAA), and Operational Improvements (OIs).

The following table illustrates the focus areas for Shuttle Upgrades over the last several years.

Main Focus	**Examples**
Shuttle Safety; Supporting the ISS	SSME Alternate turbo pump Super Lightweight Tank
Combating Obsolescence	Checkout and Launch Control system

Enhanced Capability (does not change the fundamental shuttle configuration)	Avionics Extended Nose Landing Gear Long life Fuel Cell

Space Shuttle Upgrades Selection Process

Any Space Shuttle Program Element or Project Office may propose potential candidate projects to the Space Shuttle Program Development Office (SSPDO). The recommending organization is responsible for providing a technical description of the proposed upgrade concept, the rationale for the proposal in terms of benefit to the program, and a rough order-of-magnitude estimate of cost and schedule to implement.

The SSPDO scores and weighs the proposals with respect to how well they meet Program goals and objectives of flying safely, meeting the manifest, improving supportability, and improving the system. The primary goal of the selection process is to allocate resources, on a priority basis, to the significant safety improvement opportunities and significant supportability needs. Approval of upgrade candidates is an ongoing activity of the Upgrades Review Board.

NASA's upgrade investment strategy is to pursue high priority safety upgrades, supportability and obsolescence upgrades. The principal discriminators for the high-priority safety upgrades are the degree of safety improvement, and how quickly the associated benefits can be realized.

The upgrade portfolio consists of project proposals in various stages of definition and approval. These proposals include those undergoing initial definition and feasibility assessments, those that have received formal approval for further definition and implementation planning, and projects that have been approved for implementation and thus form the base lined Space Shuttle Safety Upgrades Program content. Addendum 1 shows the Shuttle Safety Upgrade Schedule Strategy and **Addendum 2** depicts the organizational relationship of the SSPDO to the OSF.

High Priority Safety Upgrades List

The current Upgrades plan calls for High Priority Safety Upgrades which, all combined, have the potential to reduce the overall risk of a catastrophic loss of vehicle by a factor of two. All total funding figures listed below are in the President's FY 2002 Budget request.

The Cockpit Avionics Upgrade (CAU) Increments I & II, totaled $20 million in FY 2000 and $40 million in FY 2001. The total funding is estimated to be around $500 million. These upgrades will provide: 1) access to more systems data; 2) increased organization of data display and command capabilities; and, 3) improve human-to-machine interface, all of which reduces crew workload in the cockpit during all phases of the mission. Implementing the CAU into the Space Shuttle fleet in a timely manner with other Space Shuttle upgrades will: 1) reduce the cost of scheduling separate Orbiter Maintenance Modification periods, 2) increase the quality of the training of Shuttle astronauts, and 3) eventually begin to further lower the Loss of Vehicle (LoV) risk.

The Electric Auxiliary Power Unit (EAPU) would have replaced the Orbiter's three hydrazine power unit. Using battery-powered electric motors to replace the hydrazine system and high-speed turbines, this upgrade would have eliminated the potential of extremely toxic and hazardous

conditions for processing and in flight. However, due to technical issues, this upgrade will not go forward and instead will be a technology development effort in FY 2002.

The Advanced Health Management System (AHMS) Phase I & II upgrades to the Space Shuttle main engines will provide improved real-time monitoring of engine performance and environmental data, will provide improved engine health advisories to the onboard crew and ground controllers, and will provide improved engine anomaly response capabilities. The AHMS will reduce the risk of catastrophic engine failure by up to 40 percent. This project has been allocated $13.8 million in FY 2000 and $17.7 million in FY 2001. The total funding is $155 million.

The Solid Rocket Booster (SRB) Advanced Thrust Vector Control (TVC) upgrade, if implemented, will replace the hydrazine power turbines currently used to drive the hydraulic pumps with helium. This eliminates hydrazine leakage/fire hazards, turbine over speed hazards, and reduces toxic materials processing hazards. This project was allocated $5 million in FY 2000 and $11 million for studies in FY 2001. The total funding is $207 million.

Safety Upgrade Studies

Studies are also being conducted in several areas of high risk. The completion of these studies is vital to successfully supporting our safety upgrade efforts and may result in the selection of additional upgrade candidates to be prioritized and reviewed within the proposed five-year period of safety upgrade development (FY 2001 – FY 2005).

Crew Escape Engineering Design Trade Study -- This is an in-depth engineering study of contingency crew survival options; extraction, ejection, crew module separation; determine feasibility, survival utility, cost, and technical impacts; increases probability of a successful crew bailout.

Thermal Protection System (TPS) Lower Surface Tile Study -- This study will develop a more durable lower surface tile for the bottom of the Orbiter which would reduce the risk of tile burn-through, reduce post-landing repair, and may provide additional micro-meteoroid and orbital debris protection.

Self-Contained Apparatus Protective Ensemble (SCAPE) Suit Improvement Study -- The objective of this study is to develop a safer and more efficient SCAPE suit used for hazardous operations during ground processing; the current suit is heavy, allows undesirable levels of carbon dioxide, and is not efficiently cooled.

Space Shuttle Abort Improvements Study -- This study will investigate Space Shuttle hardware, software and procedural improvements to eliminate/decrease specific abort scenarios, reducing the areas of no coverage, eliminate abort scenarios, and increase probability of a successful abort.

Main Landing Gear (MLG) Tire Study -- This study is investigating improved tire designs that allow for higher landing speeds, increase cross winds limits, increase the landing load limit, mitigate obsolescence issues, and improve margins for pressure leakage and colder temperature environments.

SSME Block III Study -- This study would investigate the incorporation of an Extra Large Throat Combustion Chamber and a more robust channel wall constructed nozzle, increasing performance margins and abort thrust capability and eliminating main combustion chamber and nozzle failure modes. However, due to technical issues, this study is being discontinued.

The Industrial Engineering for Safety (IES) Study – This study is a significant and comprehensive effort to increase flight and ground safety through improved handling and inspections via changes in flight and ground hardware and ground procedures and processes. Within this study, several small projects are in formulation, and a few projects in this category have been authorized for implementation.

No candidate upgrades will be approved until NASA's overall safety investment strategy has undergone external independent review by the Office of Space Flight's (OSF) Space Flight Advisory Committee (SFAC) to assure that only technologically ready projects will be pursued. Moreover, NASA must complete its full management review process to ensure that the cost is fully defined, accurate, and has sufficient reserves to ensure that it can be completed within the overall safety allocation. Approved projects will be reviewed annually, and reprioritized if necessary, to make sure that they are managed within the plan.

Supportability/Infrastructure Revitalization

Another issue of concern for the Space Shuttle Program is maintenance of the ground infrastructure that is so vital to the continued success of the program. We recognize the importance to the Space Shuttle Program of the facility structures, systems and test support equipment. That importance extends across all stages of the program from manufacturing, assembly, testing, transportation, processing, and all the way through launch, SRB retrieval, and the final landing of the orbiters. We have identified the projects that are required to revitalize the Shuttle infrastructure over the next decade. There are over 200 projects that will eventually need to be completed. Many of these projects are required to revitalize a set of buildings, systems, and equipment that were developed for the Apollo program and then retrofitted to accommodate the Space Shuttle.

The Space Shuttle infrastructure revitalization projects are predominantly focused at the Kennedy Space Center (KSC), but there are also many important projects required at Marshall Space Flight Center (MSFC), Johnson Space Center (JSC), Stennis Space Center (SSC), White Sands Test Facility (WSTF), and the Michoud Assembly Facility (MAF). The highest priority projects are at the Launch Complex 39 (LC-39) area at KSC, including projects at both Pads A & B and the Vertical Assembly Building (VAB). There are four major VAB revitalization projects needed for the roof, siding, door openings, and the door mechanisms that need to be addressed in the near future. Other key KSC projects include refurbishment of the high-pressure gaseous nitrogen and helium pipelines, communications cabling replacement, power distribution systems, and refurbishment of the crawler/transporters that move the Orbiters from the VAB to the launch pads.

The Space Shuttle Program has addressed these projects to the best of its ability. This has been accomplished while at the same time flying an accelerated set of missions over the past two years in support of the ISS, and initiating the Space Shuttle Upgrades program that will enable the Space

Shuttle to fly safely well into the second decade of the 21st century. Our Space Shuttle philosophy places the highest priority first and foremost on crew safety and then on mission success. These priorities, when coupled to the challenging budget realities facing the entire Federal government, requires us to place our funding priorities on meeting the operational requirements of the Space Shuttle and on the high priority need for safety upgrades. We have tackled the most urgent infrastructure projects, but we have had to defer action on a number of projects that we feel are very important to the program and, if not addressed in the near future, could at some point impact mission schedules. We would like to perform more infrastructure projects, and at the same time strike the difficult balance between ensuring the operational requirements of the Orbiter and maintaining an extensive ground infrastructure that is also critical for the successful long-term operation of the Space Shuttle Program.

Space Shuttle Upgrades Independent Assessments

Over the past three years, OSF has relied on several advisory organizations like the SFAC and the Aerospace Safety Advisory Panel (ASAP), to provide comprehensive review and feedback, assessing the definition and prioritization of Space Shuttle Upgrades. Both of these organizations played a key role in the definition and prioritization of the current Safety Upgrades plan.

The ASAP was established by Congress in the aftermath of the fatal Apollo1 fire in 1967 and provides NASA with an annual report outlining any findings and recommendations for improvements regarding its programs. In its latest annual report submitted last February, ASAP submitted important comments on Space Shuttle safety upgrades and infrastructure. Just last month, ASAP provided to OSF the results of the overall impact to Space Shuttle safety if Orbiter Maintenance Modifications (OMMs) are delayed until FY 2005 and 2006, and orbiter structural inspections (SIs) are retained at KSC, for orbiters Discovery and Endeavour.

In the last twelve months, SFAC, an internal committee of the NASA Advisory Council, has provided quarterly assessments of the Space Shuttle Program and upgrades. This past June, SFAC recommended to NASA that the Electric Auxiliary Power Unit (EAPU) upgrade project be redesignated as a technology project. The primary reasons given were because the EAPU technology was not mature enough, project costs were increasing, and schedule slips were beginning to occur. NASA thanks these organizations for their valuable input and will continue to rely on them for various Space Shuttle upgrades assessments in the future.

Addendum 3 summarizes the results of the independent assessments.

SSP FY 2002 Cost Issues and Mitigation Strategy

During preliminary FY 2003 budget development this Spring, increased costs to FY 2002 baseline requirements were identified totaling as much as $218 million. This projected cost increase is due to the following:

1. Content changes and growth.

    - Orbiter OMM phasing/re-estimate

- Space Shuttle main engine (SSME) alternate turbopump development support
- SSME minor components
- Orbiter operations support

1. Contractor rate increases that factored in normal inflationary labor cost growth, higher fringe benefits (driven by higher medical costs) and other non-labor escalation. Contractor rate increases have always been projected to grow at 4-5 percent per year vs. 3.5 percent assumed.

2. Core skills and business base erosion, particularly within the rocket propulsion sector of the aerospace industry.

3. Supportability/Obsolescence issues.

4. Recent price increases in natural gas and electricity are projected to continue. These increases are not limited to the aerospace sector nor to prime contractors but include industries nationwide.

NASA Headquarters has partnered with the SSP project offices and SFAC on a strategy to maintain safety while mitigating the identified cost challenge. In order to maintain a healthy content in the Safety Upgrades plan, the following upgrade initiatives have been retained in the FY 2002 budget to Congress:

1. CAU Increment I, this was just approved as a project last month.
2. AHMS Phase I
3. ET Friction Stir Weld
4. New Main Landing Gear Tires Study
5. Industrial Engineering for Safety
6. Program Integration/Studies

In addition to eliminating Program reserves, delaying infrastructure revitalization support, and the reductions due to the re-designation of the EAPU, OSF is in the process of analyzing budget decisions dealing with the following Upgrades-related initiatives for possible cancellation or deferral.

1. Advanced Health Management System (AHMS) Phase II for the SSME
2. SRB Thrust Vector Control (TVC)
3. RSRM Propellant Grain Geometry
4. Industrial Engineering for safety
5. Orbiter Maintenance Down Period (OMDP) timing and location

Safety and The Space Shuttle Work Force

At the end of FY 1999, OSF undertook an assessment of its staffing requirements at the field centers. While maintaining Space Shuttle safety as our highest priority, OSF began an intense phase of building, integrating and testing significant ISS flight elements. We were also continuing ISS Operations while planning to integrate assembly and logistics flights to the ISS. During this time we began development of High Priority Safety Upgrades to the Space Shuttle fleet.

Given this workload environment, our internal assessment of core civil service workforce requirements at four Space Flight Centers convinced us that full-time equivalent (FTE) targets would have to be adjusted upwards. In late December 1999, each Center was directed to address critical workforce shortfalls in the SSP, ISS, and Advanced Space Transportation Programs. With respect to the Space Shuttle Program, the objective was to hire employees to support the increased flight rate and the Space Shuttle Upgrades program. Since January 2000, we have seen our Space Shuttle FTE levels grow from a FY 1999 base of 1819 to a planned FY 2001 level of 1968 FTEs.

Our new hires have addressed our need for additional support in the areas of Flight and Ground Operations, hardware, and software design. In addition, the new hires have also contributed to our ability to develop and train flight engineers for future flight operations activities. Beyond the new hires, we also transferred personne1 from existing Center organizations to support on-going Shuttle Program requirements. As we move forward in maintaining our Space Shuttle flight rate and complete the construction of the International Space Station, our recent hires will increase our ability to safely and meet our program commitments.

The "Safety Culture" within our human space flight program is robust and healthy. It is a culture that is led from the front -- management demonstrates its commitment to safety by listening and rewarding, and by being willing to accept impacts to schedule in the interest of safety. Every single Space Shuttle employee is empowered to call a "time out" if they believe that there may be a potential threat to safety.

There is concern about the uncertainty facing the workforce towards the end of this decade, should a next generation RLV be ready to begin a transition with the Shuttle. NASA is very sensitive to the need to preserve a work environment that emphasizes safety, and is beginning to think about transition issues at a very early stage so that we can ensure safe operations through any transition. In addition, reducing the level and implementation frequency for upgrades could cause many of these experienced and uniquely skilled employees to seek aerospace job opportunities elsewhere. Replacing these workers could become very difficult. We will also have the same problem with vendors that provide the unique services and products NASA needs to maintain the flight elements. NASA will work with the Administration and the Congress to proactively address these issues and ensure that human space flight activities continue to have the level of safety needed.

Space Shuttle Upgrades Program and the Space Flight Operations Contract

The Space Flight Operations Contract (SFOC) is a cost-plus-award-fee performance-based contract. NASA works closely with the contractor, United Space Alliance (USA), to ensure that the "scope of work" adequately covers all technical and management activities necessary to support all ground, flight, and orbiter services required for space flight operations. These activities also include management of approved Space Shuttle Upgrades projects and the requirements for Orbiter Modification Down Periods (OMDPs), which are necessary to implement Orbiter Maintenance Modifications (OMMs) and Orbiter Structural Inspections (OSIs). Revisions to the SFOC are negotiated based on additions or deletions to the scope of work. The current SFOC contract expires in 2002, but we have two, non-priced two-year options and are in the process of starting the negotiations to exercise the first option.

Given NASA's cost issues as described in my previous remarks, NASA Headquarters, JSC, KSC, and United Space Alliance have commenced activities to develop long-range facility and staffing plans for OMDP activities. With this plan, NASA will be able to better ascertain what critical resources are required to keep the high priority safety upgrades on schedule. The plan will address the requirements for retention of critical skills in the Shuttle workforce to accomplish the necessary upgrades and sustaining engineering work.

Space Shuttle Upgrades Program and Assembly of the International Space Station

Improving Space Shuttle safety and reliability to support ISS assembly operations and utilization for at least the next decade is currently a top priority for NASA. While we may be able to alleviate the short-term SSP cost challenges by delaying OMMs and OSIs, this may also increase the long-term risk for the SSP and could impact the current schedule of assembly flights for ISS. Addendum 4 illustrates that NASA's ability to maintain the SSP is facing increasing cost challenges.

At projected funding levels we are confident that we will be able to maintain a flight rate of six flights per year until FY 2003. Beyond that point, unless cost challenges are met, the Space Shuttle may not be able to sustain the projected flight rate, seriously impacting the ISS assembly and operations (Addendum 4, Part II).

Space Shuttle Upgrades Program and the Integrated Space Transportation Plan

The President's FY 2002 Budget Blueprint reaffirms NASA's commitment to work with the aerospace industry to explore new space transportation systems that will dramatically increase safety and reliability, and reduce costs. NASA's Integrated Space Transportation Plan (ISTP) is the long-range investment strategy for the Government to accomplish its mission objectives by enabling its partners to develop a new, commercially-viable, reusable space transportation architecture, focused on NASA's priority needs.

The ISTP consists of the Space Shuttle Program, the Space Launch Initiative (SLI) also known as the 2nd Generation RLV Program and the Advanced Space Transportation Program (3rd Generation research and in-space transportation technology). Under the plan, the Space Shuttle will be maintained through investment in the safety upgrades. The Space Launch Initiative formulates and implements risk reduction activities and technologies to enable development of a 2nd Generation Reusable Launch Vehicle. Addendum 5 illustrates the ISTP concept.

The follow-on RLV to the Space Shuttle will be operating from the subsonic (Mach < 1) to the hypersonic range (Mach > 5) of the high-speed envelope. Currently, the Space Shuttle orbiter is the only reusable operational vehicle in the world that flies in the hypersonic regime. With 106 Space Shuttle flights completed, NASA has accumulated a total of 50-60 hours (ascent-descent) of hypersonic flight over twenty years. The Space Shuttle could play a valuable role in assisting SLI to evaluate promising 2nd RLV technologies if SLI provides the necessary funding for ground and/or flight tests during one or more Space Shuttle missions. An orbiter outfitted with SLI technology demonstrations for flight software, computers, internal vehicle health management system, and non-hazardous fluids could significantly reduce the development time and financial resources needed to flight-test these prototype systems. By acting as a technology pathfinder, SSP will be supporting SLI management and technical processes, to efficiently and accurately accumulate and analyze data

that will improve/influence the various RLV concepts and designs. This type of effort would certainly minimize the operational transition problems from the SSP to an operational 2nd Generation RLV.

The two programs are working together to bring the Space Shuttle heritage and lessons learned to the SLI concepts and evaluating the benefit of key technologies. The large majority of technologies being pursued in SLI is relevant to the space shuttle and can be evaluated using the space shuttle as a reference point. The space shuttle and SLI programs are also investigating other areas of collaboration and synergy.

The following list summarizes some of the design features that the SSP could help to influence for SLI:

1. Number of toxic fluids
2. System margins
3. Number of systems with build-in-test (BIT) build-in-test equipment (BITE)
4. Number of confined spaces on vehicles
5. Hours for turnaround between launches
6. Number of different propulsion systems
7. Number of unique stages for flight and ground
8. Number of active ground systems required for servicing

Current plans call for the Space Shuttle to be maintained until the 2nd Generation RLV can achieve "Initial Operating Capability" (IOC). That milestone is projected to be the start of FY 2012. Under the ISTP, the transition from the Space Shuttle to the new vehicle could begin as early as FY 2009 and be completed by the end of FY 2011.

Concluding Remarks

Mr. Chairman, safety continues to be our top priority. The American taxpayers have every right to expect the Space Shuttle program they pay for to operate safely and efficiently. However, our ability to continue to perform to the highest safety standards in the long-term will require that we continue to address the critical needs of an aging Apollo era infrastructure.

Safety, maintainability and obsolescence issues will need continuing attention to ensure that the needs of our Nation's human space flight program can be met while next generation RLV technology is being developed. Safety investments must continue in order to ensure a safe program for as long as we are asked to fly.

Mr. Chairman, this concludes my remarks for the record. I would be happy to answer any questions you may have. Thank you very much for your attention.