



Given at a Science and Space  
Hearing: **Human Spaceflight: The Space Shuttle and Beyond**  
Wednesday, May 18 2005 - 10:30 AM - Russell 253

The Testimony of  
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**Statement of Dr. Scott J. Horowitz**  
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**To the Subcommittee on Science and Space of the Senate Committee on Commerce,**  
**Science, and Transportation**  
**Hearing on "Human Space Flight: The Space Shuttle and Beyond"**  
**Senate Russell Building Room 253**  
**May 18, 2005**

Madame Chair and members of the Subcommittee, thank you for the invitation to appear before you. I appreciate the opportunity to discuss evolving the Space Shuttle systems, and in particular leveraging the hardware, infrastructure and people to minimize development schedules and to provide a safe, reliable, cost effective method to insure human access to space along with heavy lift for exploration when we retire the Space Shuttle in 2010.

I have had the honor and privilege to serve our country as an Air Force F-15 fighter pilot, test pilot, and NASA astronaut on four Space Shuttle missions as a pilot and commander including a microgravity/science mission, Hubble servicing mission, and two missions to the International Space Station. Upon retiring from NASA and the Air Force I joined the ATK Thiokol team as the Director of Space Transportation and Exploration. These experiences, coupled with a PhD in Aerospace Engineering from Georgia Tech, have provided me with a unique perspective on what it takes for our team to conduct successful human space flight missions.

We at ATK are excited about the President's Vision for Space Exploration and fully support NASA's new administrator, Mike Griffin, in his efforts to make this vision a reality. I firmly believe that we can safely and affordably transition the Space Shuttle program to support the Exploration program by leveraging the flight-proven and human-rated elements that exists today. This will enable us to retire the orbiter, and eliminate any gap in U.S. Human Space Flight capability. If we can start soon, we can fully meet the demanding needs of heavy lift and crew transportation more safely, more reliably, and more affordably than with any other option by the end of the decade.

NASA's need for a safe, reliable, affordable method of transporting crews to and from Low Earth Orbit can be achieved as we move forward with exploration. But I believe it tremendously important to learn from the lessons of the past and apply them to the future of human space flight. The Columbia Accident Investigation Board concluded that "The design of the system should give overriding priority to crew safety, rather than trade safety against other performance criteria, such as low cost and reusability, or against advanced space operation capability other than crew transfer." I totally agree with this conclusion. Additionally, in a memo dated May 4, 2004, the NASA astronaut office offered their consensus on the future by stating: "Although flying in space will always involve some measure of risk, it is our consensus that an order-of-magnitude reduction in the risk of loss of human life during ascent, is both achievable

with current technology and consistent with NASA's focus on steadily improving reliability" (Attachment 1: Astronaut Office Position on Future Launch System Safety, Memo, CB-04-044, May 4, 2004).

The first step is to realize the tremendous capabilities that already exist and that can be utilized in the future to support our nations exploration vision. The space shuttle propulsion systems are the most reliable systems in the world. The Reusable Solid Rocket Motors used in the space shuttle launch phase have flown 226 times with significant engineering, inspection, and testing supporting well understood operational margins; the Space Shuttle Main Engines have flown 339 times and have over a million seconds of testing! These reliable and proven propulsion systems coupled with the External Tank constitute the Space Shuttle "propulsive backbone" and provide us an impressive capability to lift large payloads to Low Earth Orbit. Every time we launch a Space Shuttle we send about 240,000 pounds (over 100 Metric Tons) to Low Earth Orbit! More importantly, we have the existing infrastructure and skills today to produce, launch, and operate this amazing hardware. As I travel around the country sharing the adventure of flying in space, I point out that it isn't the thrust of the Solid Rocket Motors and Space Shuttle Main Engines that propel us to space, but the dedication, hard work, hopes and dreams of the many skilled and talented people that develop, manufacture, and prepare these systems that carry us to orbit. Transitioning this workforce to support Exploration is key to our success.

By evolving the shuttle's propulsive backbone to provide a heavy lift launch capability we can engage this talented, skilled workforce, and utilize our existing infrastructure. Because the orbiter vehicle sustaining, launch processing, and associated logistics drive the cost of the existing shuttle program, removing the orbiter will result in a significant reduction in cost. The propulsion elements of the space shuttle program only make up a fraction of the overall costs, making utilization of these systems extremely attractive for cost, safety, reliability, and sustainability. Not only is this launch system very affordable, it is the lowest cost in terms of dollars per pound to low earth orbit.

Two primary options are being reviewed to provide heavy lift (greater than 150,000 pounds) —The first option replaces the orbiter vehicle with a side-mounted expendable cargo carrier utilizing the propulsion backbone and the same connections as the orbiter. This approach minimizes configuration changes while providing the capability to launch 170,000 to 200,000 lbs to LEO. A second option, providing capability up to 250,000 to LEO, is to remove the orbiter, move the main engines below the External Tank, and add an optional second stage and cargo carrier to the top of the external tank. The modifications required for option 2 are more extensive than option 1 but option 2 has the added advantage of being able to provide larger and heavier payloads to Low Earth Orbit.

Heavy lift capability in the ranges that I have mentioned is significant in that it offers the lowest risk and highest mission reliability, and ultimately the lowest cost for exploration missions. It would take 5 to 7 launches using smaller existing launch vehicles to accomplish what a single 170,000 to 250,000 pound launch vehicle can do.

The cost of breaking the exploration missions into numerous smaller pieces to accommodate a smaller launch vehicle is cost prohibitive. Each smaller element will have to become a complete spacecraft on orbit while performing an automated rendezvous and docking and be burdened with all the systems required to survive and operate in space including power systems, thermal control systems, propulsion systems, guidance navigation and control

systems, docking systems, etc. Then there is the cost of the infrastructure required to support the surge rates needed for multiple launches of smaller launch vehicles that would be required during a lunar or Mars campaign. This combined with all of the associated operational costs make the use of smaller launch vehicles for exploration missions cost prohibitive. Add to that the impact on mission reliability as a result of performing so many launches and associated on-orbit assembly operations and one quickly realize that the chances of accomplishing multiple moon or Mars missions using smaller launch vehicles is slim to none. A heavy lift launch vehicle eliminates costly and complex in-space docking and on-orbit assembly and all of the associated supporting hardware, testing, checkout, and sustaining operations. Most significantly, a heavy lift launch vehicle simplifies the exploration architecture driving down costs for sustaining and logistics.

In combination with the heavy lift launch capability, it is equally important to leverage existing human rated propulsion elements and focus on the safest way to put the crew in space. Utilizing a single space shuttle reusable solid rocket motor for the first stage of the crew launch vehicle is an ideal application of simplicity. The motor is already human rated and has an outstanding proven safety and reliability record. Add to this reusable first stage a previously developed human rated 2nd stage rocket engine, either a simplified version of the Apollo engine that took astronauts to the moon, the J-2S, or a space shuttle main engine and you have a very simple, cost effective launch vehicle solution, built upon human rated heritage.

Albert Einstein once said: "make everything as simple as possible, but not any simpler". The crew launch vehicle that I just described is the simplest launch vehicle that can deliver almost 50,000 pounds to Low Earth Orbit. This simplicity and use of highly reliable components results in the safest launch vehicle possible for transporting astronauts to space. In fact a recent reliability and crew safety assessment of the SRB/J-2S Launch Vehicle conducted by Science Applications International Corporation (Attachment 2: SAICNY05-04-1F, 1 April 2005) concluded "...the SRB/J-2S derived launch vehicle forecasted crew safety level, as measured in missions where the crew is lost in a total number of missions, is 1 in 3,145..." This is an order of magnitude better than today's capabilities. Another important feature of this design is that it has sufficient performance to fly trajectories to orbit that are compatible with a crew escape system. Other launch vehicles with insufficient thrust require the launch vehicle to fly higher, steeper, and longer, exposing the crew to extensive periods (up to three times longer) where a simple ballistic crew escape is not survivable.

The other major benefit of this evolved approach is that because of its simplicity and reliance on already developed hardware, this launch vehicle can be available soon. In fact, a demonstration launch could be conducted in 2008 and be ready to fly the CEV about when the Shuttle is scheduled for retirement. We could also have the heavy lift version ready at about the same time, and by leveraging the resources of the current shuttle program we could save significant dollars. We have the talented work force, facilities, and most of the major hardware components in hand. By evolving what we have and only developing new components where needed, we can drastically reduce the cost and schedule to provide the capabilities we need to safely transport astronauts to orbit and provide the heavy lift required to conduct space exploration.

The approach that I have described also provides a means of safely transitioning from the current Space Shuttle System to the launch system required to support the Exploration Vision. The SRB/J-2S launch vehicle could easily be used to carry crew and cargo to the International Space Station, or be used as a highly reliable payload carrier to support U.S. assured access

to space requirements.

By leveraging the current Space Shuttle resources we have the ability to get astronauts to/from Low Earth Orbit, an order of magnitude safer than we do today, for a very affordable cost and on a schedule that avoids a “gap” in U.S. human space flight capability. We also have the propulsive backbone of the Space Shuttle System today that is proven and ready to provide a cost effective heavy lift capability needed to do exciting exploration of the moon and enable us to reach Mars and beyond. In summary we have a Safe, Simple solution that we can have Soon. We owe it to our children and future generations to do so.

Thank you for the opportunity to share my thoughts with you, I will be pleased to respond to any questions that you may have.