

Written Statement for Testimony

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Good morning, Chairman Hall, Ranking Member Johnson and members of the committee. On behalf of the Boeing Company, I wish to convey my deepest gratitude for your continued support of human spaceflight. Your efforts have enabled a safe fly-out of the Space Shuttle, completion of the International Space Station, and established a path forward for the future of human space exploration. Without your committees' support none of these achievements would have been possible. It is an honor to be a participant with this distinguished panel to elaborate Boeing's development status to support reducing the gap in U.S. crewed access to the International Space Station.

Programmatic Purpose for Commercial Crew

There are 3 cornerstones of NASA's path forward for human space flight: Utilization of the International Space Station, Commercial Crew for transportation to low Earth orbit, and development of a capability for human exploration beyond low Earth orbit. By providing affordable crew transportation to the International Space Station, Commercial Crew will increase utilization of this on-orbit laboratory and free up funding and resources for NASA to focus on exploration beyond low Earth orbit. Because of this relationship, Commercial Crew should not be viewed as a competitor with deep space exploration programs, but instead as a complementary program that contributes to achieving NASA's overall objectives.

Our Design Solution

In selecting a design solution for Commercial Crew, Boeing adopted 3 overarching principles: (1) we would focus on transporting crew to low Earth orbiting platforms only so the vehicle capabilities could be kept as simple as possible; (2) we would use as much "off-the-shelf", proven technology as possible in order to reduce development risk and improve cost and schedule certainty; and (3) our design would be as uncomplicated as practical to improve reliability and safety and to enable low operations costs. The solution we reached, based on these criteria, was an Apollo shaped capsule launched into orbit on the proven, dependable Atlas V. The Atlas family of rockets has a history of 98 consecutive successful launches and the Atlas V itself has a string of 27 consecutive successful launches. To compliment this reliability, our spacecraft includes a robust abort system that can carry the crew to safety in the unlikely event there is a problem with the launch vehicle during all phases of ascent. The capsule re-enters using an ablative heat shield and parachutes to a landing on a lake bed, cushioned by airbags. These features, in combination, lead to a very reliable system with a minimum of components that need to function properly for crew survivability. The use of existing systems and low complexity also results in low development risk ensuring the government that Boeing will be able to complete the development and testing of the system and that a return will be received on the taxpayer's investment. Finally, this

design will lead to a system with reasonable operating costs that will enable a U.S. solution that is competitive with current per seat prices for Russian Soyuz transportation.

Current Progress

To date on our program we have completed several significant design milestones and development tests. During the first phase of the Commercial Crew Development procurement, we completed a System Requirements Review, a Subsystem Definition review and Initial Safety Reviews. Also during the first phase, we completed development testing that included: Drop tests to prove operations of the airbags; Fabrication of pressurized structure using a new innovative technique that requires no welds and significantly reduces cost; Development of a simulator that demonstrates the capability to automatically dock with the International Space Station; Test firing of a development version of the abort engine; and completion of wind tunnel tests to characterize the aerodynamic loads during the critical abort phase.

Future Milestones

Looking forward, prior to completion of the second phase of Commercial Crew Development in June of next year, we will: Mature the design of the complete, integrated system, which includes the spacecraft, launch vehicle, and ground systems, through a Preliminary Design Review; Perform a parachute drop test from a helicopter ending with a touchdown on deployed airbags; Integrate the Emergency Monitoring System of the Atlas V with the avionics of Crew Space Transportation (CST)-100 to demonstrate the required data communication in the event of a launch abort; and test fire a new, lighter weight version of the abort engine. Assuming we are selected by NASA for the next procurement phases and that adequate funding is available, we will complete our Critical Design Review, the 90% point in the design process, by the spring of 2013 and perform an ascent abort test later that year. We also plan on flying three flight tests, which will culminate with the launch of 2 Boeing test pilots in 2015, leading to the capability to fly crew to the International Space Station by late 2015.

Programmatic Challenges

Human space flight is challenging and any program to develop a capability to transport humans in space must address these challenges. However, we have been transporting humans into earth orbit in capsules for nearly 50 years and by selecting a design and technologies that are proven, we have reduced the technical challenges of the program to manageable levels. There are two significant challenges that remain from Boeing's perspective and they are programmatic in nature. The first is stable funding. If we are to achieve an operational capability by 2015, adequate funding levels

must be provided over the next 4 years. The second is addressing liability risk associated with the potential for accidents that result damage to property or in death or injury to a crew member or passenger. Although the likelihood of these occurrences is extremely low, the losses would be tragic and the potential monetary consequences could be very high. With limited performance history, it will be difficult for industry to insure against these monetary losses at reasonable rates. As such, in order to close a business case, it will be necessary for NASA, the FAA and Congress to work together to provide indemnification and liability limitations.

Procurement Approach

There are two key attributes that should result from the Commercial Crew procurement approach in order to enable success. The first is creation of an operating environment that supports decision velocity. Because the risks and challenges of transportation to low Earth orbit are relatively well understood, as compared to more complicated missions carrying humans beyond the vicinity of earth, it is possible to safely design and operate a system in an environment where more decision authority is retained by the contractor. This reduces the required coordination and expedites the decision making process, leading to lower costs. The second attribute is that the contractor should retain intellectual property rights. This is necessary to encourage investment in establishing a commercial market beyond transportation of NASA funded passengers to the International Space Station. Boeing believes that both these attributes can be achieved using a FAR based contract. Furthermore, whether required by the procurement approach or not, we will use the same design processes and design standards we use for all development programs, including commercial programs such as commercial satellites and commercial airplanes. Processes like design reviews, safety reviews, documented manufacturing and operations procedures, configuration management, parts traceability and failure modes and effects analysis are used on all Boeing programs, government and commercial, because we have proven to ourselves, over time, that they are necessary to execute a successful program leading to a reliable design and safe operations.

Insight/Oversight

NASA has defined an environment for insight and oversight that we think will work well in the Commercial Crew environment. To achieve insight NASA will embed personnel as part of the development teams with access to development data so the government remains cognizant of design decisions and program status without the need for specially generated documents, reports or reviews. NASA oversight, which is the process through which NASA elects to direct changes in our design in order to meet top level human certification requirements, is limited to major design reviews, and reserved for those situations where it is deemed necessary to ensure crew safety and mission

success. Our experience during the first two phases of Commercial Crew Development has validated this approach. NASA personnel are included in our engineering reviews and program status meetings and they have participated in a manner that adds significant value through offering input to design discussions based on experience and concerns from past programs, but supporting the design decisions we make during the process. Oversight has not been a part of these early phases but through our design reviews we have received the opinions of NASA program leadership and we've iterated our design based on this so that only a very small number of design disconnects of any consequence remain. These will be discussed during our preliminary design review this March, and assuming we are selected to continue, will be resolved during the early parts of the next program phase.

Size and Vitality of the Commercial Market

With regards to size of the potential market, it is clear there is a commercial market for transportation to low Earth orbit. Proof of this can be found in the fact that 7 private space flight participants have paid for flight on Russian spacecraft to the International Space Station, and that Bigelow Aerospace has signed Memorandums of agreement with at least 6 countries that are interested in leasing space on the Bigelow Space Complex. The depth of these markets is uncertain though and a responsible business case cannot be closed on the commercial business alone. Our business case assumes only NASA purchased transportation to the International Space Station and treats revenue from private space flight participants and commercial transportation to Bigelow's space complex as upside. We have teamed with Space adventures, the company that brokered seats on Russian flights to the International Space Station, and with Bigelow Aerospace to ensure the system we are developing will meet their needs and to allow them to strengthen their offerings with the promise of safe and reliable transportation. The commercial crew market would not be as attractive if NASA were the only potential customer, but at the same time to ensure a successful venture, we must be certain we can have a viable business based on NASA flights alone. This is important from the government's perspective as well. It shouldn't be necessary for the government to gamble on the development of a commercial market in order to ensure a viable business will be in place to meet its needs for transportation to the International Space Station.

Closing

In closing, commercially provided transportation to low Earth orbit is the right solution for enabling a complete and robust portfolio of NASA programs in science and human space flight. The risks in flying spacecraft to low earth orbit are well understood. We've been completing successful low Earth orbit missions since John Glenn's historic flight in 1962. It's time to leverage the efficiencies of a different model

for the relationship between NASA and the contractors for the part of space exploration where the risk levels warrant it. Commercial transportation to low Earth orbit supports lower cost utilization of the International Space Station and makes additional funding available for human exploration beyond low Earth orbit.