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January 17, 2018

Chairman Babin, Ranking Member Bera, and members of the Committee, on behalf of The Boeing Company, thank you for the opportunity to provide an update on the Commercial Crew Program.

We have been a partner with NASA on every domestic human spaceflight program, Mercury, Gemini, Apollo, Apollo-Soyuz, Space Shuttle, International Space Station, and now Commercial Crew and the Space Launch System. We have a unique understanding of the strategic importance of having an American-made crew transportation system for safe, reliable and affordable access to low-Earth orbit. And, we understand that having this capability as soon as possible is critically important for the International Space Station to continue its important mission as a world-class national lab.

The first flight of the CST-100 Starliner will represent a major milestone in the return of human spaceflight launch capabilities to America. To make that successful, we have the full support of The Boeing Company, and a strong, value-added relationship with our NASA partner.

Background

Boeing's vision is to connect, protect, explore and inspire. Those concepts span everything we do as a company – commercial, defense, and services. Human spaceflight fits squarely within that vision and is a market Boeing is firmly committed to. When we entered our 100th year of operation, Boeing reaffirmed the importance of space in our own strategy by naming human space exploration as one of our six key focus areas for our Defense, Space & Security business unit.

We are proud to be NASA's trusted partner as we continue to innovate critical systems for human spaceflight activities in low-Earth orbit and beyond. Then and now, Boeing's success depends entirely upon the quality and safety of our products. As NASA continues to advance scientific research aboard the International Space Station (ISS) and extend exploration deeper into our solar system with the Space Launch System (SLS) and Orion, the Commercial Crew Program is pivotal to achieving NASA's human exploration vision within the economic constraints of a larger national agenda.

The Commercial Crew Program's immediate purpose is to provide safe, reliable and affordable access to low-Earth orbit, including the International Space Station, ending America's reliance on Russian transportation for U.S. crews.

Since the inception of the NASA Commercial Crew Development effort, CCDev, in 2009, Boeing has utilized a robust program management approach, proven spaceflight systems and hardware, and a rigorous systems engineering development and certification approach to provide NASA and U.S. taxpayers with the most reliable solution to meet national needs.

Boeing's rigorous engineering process led to the successful completion of all development phases of NASA's Commercial Crew Program. We are proud to be the only Commercial Crew supplier to close NASA's previous development phase, the Commercial Crew Integrated Capability (CCiCap), on-time. CCiCap, as well as the Certification Products Contract phase of the program, laid the groundwork for our design completion and path toward certification during this Commercial Crew Transportation Capability (CCtCap) contract, which was awarded in September 2014.

In response to the request of the Committee, my testimony addresses a review of our capabilities, progress, key milestones and challenges ahead, and the risks we are mitigating while preparing to fly, and ultimately receive NASA certification.

1. Review of Commercial Crew Transportation System capabilities, architecture and systems

Our Commercial Crew Transportation System, called the CST-100 Starliner, is a "full service" system. It provides all elements needed to transport crew and cargo to and from orbit, including crew training and mission planning, cargo integration, spacecraft assembly, integration and testing, launch vehicle integration and testing, launch and mission operations, and crew and cargo recovery.

Boeing's robust design, using proven technologies to reduce system complexity, results in improved reliability and safety. It reduces development risk, improving predictability of cost and schedule. It also lowers overall cost. Our design also will support transportation services to emerging low-Earth orbit platforms, such as commercial space stations.

In our concept of operations, Starliner launches from Florida's Space Coast on a United Launch Alliance (ULA) Atlas V rocket, the most reliable rocket ever flown with a 100% success rate on 74 missions and counting. The fully autonomous Starliner is baselined for five passengers plus cargo on missions to the International Space Station, but it also has the versatility to accommodate up to seven passengers and cargo. After an eight-hour flight, the Starliner will rendezvous with a low-Earth orbit platform, such as the International Space Station. The capsule stays attached to the orbiting platform for at least six months to serve as the crew's on-orbit "lifeboat." When it is time to return crew members to Earth, the capsule detaches from the platform, jettisons its service module and re-enters the atmosphere behind the protection of an ablative heat shield. Boeing's Starliner is currently the only capsule being certified by NASA to land on land, which allows quick access to crew members and valuable scientific payloads. It uses a parachute and airbag landing system for a comfortable deceleration and safe impact.

A land landing also increases reusability when compared with a water landing. The Starliner capsule can be refurbished and is reusable for up to 10 missions. The system does support water landings after pad or ascent aborts, targeted contingency landings, and emergency landings – providing additional measures of risk mitigation.

We have designed our capsule to be compatible with a variety of launch vehicles, but chose the Atlas V for the first test flights and service missions. Once additional launch vehicles have demonstrated sufficient technical and schedule reliability necessary for crew flights, we maintain the ability to on-ramp them in our ongoing effort to drive life-cycle affordability.

2. Update of progress made and milestones ahead

Our approved certification plan follows a process very similar to the process that we followed for the space shuttle and space station, and is consistent with Boeing commercial programs, such as commercial airplanes and satellites. From a payable milestone perspective, we have completed 21 of 37 development milestones and 7 of 24 post-certification milestones under the CCtCap contract. We've made tremendous progress, and have overcome several issues that are typical of complex development programs since we last testified in 2015.

- Our launch vehicle, the Atlas V, has flown 74 missions with 100% mission success, providing unparalleled safety, mission assurance and schedule reliability.
- The Crew Access Tower at Space Launch Complex 41 has been erected and other site modifications are progressing well ahead of need.
- The launch vehicle that will power our first uncrewed flight is in final production at the United Launch Alliance factory in Decatur, Ala., and the major components for the crew test flight are moving through the factory.
- All of our test and flight spacecraft are fielded or are in build.
- The Structural Test Article consists of a crew module, service module and launch vehicle adapter. The test article entered test in December 2016 and is undergoing a complex test series of static loads, modal analysis, ordinance operation and separation system verification. The test series is greater than 50% complete.
- The Service Module Hot Fire test article has been delivered to the test site and is near completion of the first test phase, cold-flow testing. Following cold-flow test completion, the system will be loaded with propellant, and all propulsion system functions, including abort, on-orbit maneuvers, and the de-orbit burn series will be tested.
- Spacecraft 1 has finished initial power-on testing, ground verification testing, and is undergoing final outfitting prior to mate of the crew module and service module. This test article will be sent to the test site for the Pad Abort Test in mid-2018.

- Spacecraft 2 initial power-on testing will occur in early February, followed by final outfitting and mate prior to being shipped to the test site for environmental qualification testing early this summer. The spacecraft will undergo thermal vacuum, acoustic vibration, and emission testing before returning to Florida for retrofitting to support the Crew Flight Test in Q4 2018.
- Spacecraft 3 lower dome secondary structure is in build to support initial power-on testing in April. This spacecraft will be used for the un-crewed flight test in Q3 2018.
- Work across all systems and components is progressing to near-term completions.
- The land landing qualification testing has successfully completed, proving our system can safely land on land under both nominal and failure cases.
- Three full-scale parachute drop tests remain, including one later this month.
- Over 75% of our component qualification testing has been successfully completed.
- Flight software released its latest drop in December and currently stands at over 98% of full functionality.
- All design drawings have been released.
- Over 25% of the verifications to be approved by NASA have been completed and delivered, and over 11,000 hazard control verifications have been closed out and delivered.
- Training is under way with NASA's Commercial Crew Cadre and our Mission Operations team thanks to new, state-of-the-art Starliner training systems at the Johnson Space Center.
- Our Flight Control Team products are at greater than 80% maturity, and multiple integrated simulations have already been completed.

As you can see, the team has successfully transitioned from design into integrated build and test. While we're focused on meeting our 2018 forecast dates, we are fully committed to performing those safely. We bring the same quality to commercial spaceflight that we bring to our service men and women, astronauts on-board the station, and to the traveling public, every day.

4. Development program challenges and risk mitigation

As with any complex development program, we have faced and overcome a number of challenges – both technical and programmatic. Several of these issues affected our original schedule. I am proud of the response by our team on how they have address these challenges head-on to ensure the robustness and mission assurance of our system.

A key strength that Boeing provides to NASA is that we have a host of resources in a wide range of engineering and manufacturing disciplines, and we have applied this expertise

early to drive resolution of emerging risks. This deep talent pool and ability to share lessons learned across a wide range of aerospace development and production programs has been instrumental in addressing and resolving risk to NASA's benefit.

Closing

The last time I testified before this Committee in 2015, there were concerns over whether or not NASA and its partners were providing the Aerospace Safety Advisory Panel (ASAP) with enough insight into our systems and processes. I promised this Committee, and General Dyer, that Boeing would provide the ASAP the appropriate level of access into the development of the Starliner.

In fact, we offer all of NASA's advisory committees and reporting agencies – including the Government Accountability Office – full insight into our progress, challenges and schedule. We believe transparency is essential in this business, and I personally feel that the reviews, findings and feedback add value to our systems and processes.

We are well aligned with our customer on crew safety and mission assurance, and our analyses show that we exceed our requirements for crew safety. We also are making steady progress on achieving certification. In fact, we recently met with NASA to conduct a thorough review of our design, performance, verification, validation, test activities and station integration plans to ensure flight tests can continue in confidence. That milestone – called the ISS Design Certification Review – went well and will close following the completion of the contractually required service module hot-fire test mentioned above.

We would like to thank everyone who has contributed to this program. Colleagues at Boeing and NASA, the thousands of supplier employees across 38 states – your hard work, dedication and passion is unparalleled. To the members of this Committee and staff, thank you again for your continued support and the opportunity to be here today.