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Chairman Palazzo, Ranking Member Edwards, and members of the Committee, on behalf of The Boeing Company, thank you for the opportunity to testify today to provide an update on Boeing's Commercial Crew Transportation System. We are honored to be part of NASA's Commercial Crew Program to provide safe and reliable crew transportation to support the International Space Station mission.

Background

This year, The Boeing Company enters its 100th year of developing human transportation systems. What began as a few airplanes flying mail routes on a small government contract has advanced to a thriving global enterprise serving the needs of millions of commercial airline passengers and servicemen and women around the world. Then and now, Boeing's success depends entirely upon the quality and safety of our products.

Our space experience extends to every human-rated system since the beginning of America's space program; from Mercury, Gemini, and Apollo to the Space Shuttle to the International Space Station.

As NASA continues to advance scientific research aboard ISS and extend exploration deeper into space with 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 the International Space Station and low-Earth orbit and end America's reliance on Russian transportation for U.S. crews.

From the start of the first phase of the NASA Commercial Crew Development Program, CCDev, in 2009, Boeing implemented a robust program management approach, proven space flight systems and technology and a rigorous systems engineering development and certification approach to provide NASA and U.S. taxpayers with the most reliable solution to maintain schedule to meet NASA's mission.

This proven development process has led to Boeing successfully completing all phases of NASA's Commercial Crew program. We are proud to be the only Commercial Crew supplier to have closed NASA's Commercial Crew Integrated Capability contract on-time and the only supplier to successfully complete a Critical Design Review. This has laid the framework for completing our design during the current Commercial Crew Transportation Capability, CCtCap, phase of the program, which was awarded back in September.

In response to the request of the Committee, my testimony addresses a review of our Commercial Crew Transportation System capabilities, our progress, key milestones ahead, the challenges we face and risks we are mitigating as we prepare to certify and fly our system.

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

Boeing's simple 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 will also support transportation services to other low-Earth orbit platforms, such as the commercial space station, planned by Bigelow Aerospace.

Our Commercial Crew Transportation System 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; Crew Space Transportation (CST)-100 spacecraft assembly, integration and test; launch vehicle integration and testing; launch and mission operations; and crew and cargo recovery.

We apply an integrated approach to meet human rating requirements, leveraging our Space Shuttle and ISS program experience, along with our certification products approved by NASA during the Certification Products Contract, to continue guiding system development in compliance with NASA human rating requirements.

In our concept of operations, our CST-100 spacecraft launches from the Florida Space Coast on an Atlas V rocket, the most reliable rocket today with 100% success over 52 launches and counting. The fully autonomous CST-100 design is baselined for five passengers plus cargo, and can accommodate up to seven passengers or a mix of crew and cargo. After an eight-hour flight, the CST-100 capsule will rendezvous with a low-Earth orbit platform such as ISS. The capsule stays attached to the orbiting platform for up to seven 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 space platform and re-enters the atmosphere behind the protection of an ablative heat shield. Boeing's CST-100 capsule is currently the only capsule being certified to land on land, which allows quick access to crews and valuable science. It uses a parachute and airbag landing system for comfortable deceleration. .

A land landing also increases reusability when compared with a water landing. The 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 alternate launch vehicles. Once these launch vehicles have demonstrated sufficient technical and schedule reliability necessary for crewed flight, we maintain the ability to on-ramp them in our ongoing effort to drive life-cycle affordability.

2. Update of progress made

We continue to work diligently to maintain our planned test flight schedule, despite a delay in contract award and subsequent stop-work associated with the protest denied by the Government

Accountability Office. Boeing has completed on schedule the first two milestones and the first two parts of a three-part third milestone.

Our first milestone, the Certification Baseline Review, was completed in October 2014, laying the ground work with NASA for our path to human-rated certification of our system.

The second milestone, the Ground Segment Critical Design Review, was completed in November. This was a review of the ground operations systems – including the facilities and processes for assembly, integration, and system test – as well as the mission operations systems – the control center, training systems and simulators and ground software that will be used to plan, train, and fly the crew.

The third milestone, the Phase II Safety Review, includes a review of Critical Design Review (CDR) level requirements and system architecture and design, with associated safety products to assess conformance with the certification process. It addresses updates to hazard reports/analyses including cause identification, development of controls, and specific safety verification methods. We completed the first two parts of this milestone in December and February, and the third part will follow in June.

The first four months of the program have seen significant progress in addition to the milestone-level accomplishments. Boeing has procured two Atlas V launch vehicles from United Launch Alliance for its two certification flight tests. Incidentally, the Atlas V that will launch the first uncrewed CST-100 test flight will be the 76th mission for the Atlas V family. The first crewed flight test of the CST-100 will fly on the 80th Atlas V mission.

Earlier this month, we began construction on the Crew Access Tower for the Atlas V launch pad at Space Launch Complex-41. The tower will be built off pad and assembled on pad between launches to maintain normal operations. The crew tower is needed to meet the requirements of a human-rated launch pad and will take approximately 18 months to complete.

Work is also underway on the Atlas V Emergency Detection System, part of the Abort System that supports human-rating of our integrated Commercial Crew Transportation System.

The former orbiter processing and engine maintenance shop, Orbiter Processing Facility (OPF)-3 at the Kennedy Space Center, has completed handover to Boeing and is now a modernized state-of-the-art facility that will support manufacturing, assembly, integration and test for the CST-100 spacecraft. We call the new facility the Commercial Crew and Cargo Production Facility, or C3PF. We have installed tooling, including the lower dome lift fixture and the upper and lower dome assembly jigs. We have received and inspected more than 150 pieces of flight hardware at C3PF so far. The hardware being delivered now will form the structural test article. Later this year, hardware for the qualification test vehicle will arrive, followed by the orbital and crewed flight test vehicle hardware.

System software and avionics development continues to advance, with recent release of software Engineering Release 4.0 and completion of early integration tests. We have progressed with

the development of our Avionics and Software Integration Laboratory (ASIL), finalizing the lab's layout and receiving from our suppliers a full ship set for ASIL system, flight and display computers.

We have completed additional Wind Tunnel Testing validating our addition of a perforated ring to eliminate launch buffeting in the integrated stack. Additional Wind Tunnel Tests have been completed to assess abort turn around performance, maneuvering jet interaction during abort and dynamic stability.

Landing system testing is also ongoing; we recently completed additional airbag water landing tests and a rapid inflation test.

Our space suit supplier has provided an innovative, safe and comfortable space suit prototype, and we are making significant progress with cabin interior design features. We continue to refine the human interface to our spacecraft and have defined all content for our remaining flight displays. We have completed key prototype evaluations for suit glove usability, keypad usability and suit helmet visor field of view.

With the completion of early CCtCap performance milestones and significant ongoing development testing, the team is working hard to finish the design. We previously completed multiple design analysis cycles in which we analyzed our design against NASA human-rating requirements. Now, under CCtCap, we have initiated the first Verification Analysis Cycle, working back in a closed-loop process to develop the objective evidence that will support certification of our baselined design to the NASA human-rating requirements.

Our approved certification plan follows a process very similar to the process that we followed for Space Shuttle, Space Station and is consistent with Boeing commercial programs, such as commercial airplanes and satellites.

3. Upcoming significant milestones

Our efforts to date under CCtCap and prior contract phases come together next month in March with our fourth CCtCap milestone, a Delta Integrated Critical Design Review. In the Delta Integrated CDR, we'll review the baseline design established during the earlier CDR completed under CCiCap, as well as new design content, to demonstrate compliance of our integrated design across our system's launch, spacecraft and ground segments. The review will include hardware, software, facilities, support equipment and plans that satisfy system-level, segment-level and module-level requirements. The Delta Integrated CDR demonstrates that the design is mature enough to proceed to assembly, integration and test activities.

Over the remainder of 2015 and 2016, we will complete a number of key development tests and reviews. These milestones show progress in completion of our Structural Test Article and Qualification Test Vehicle, demonstration of flight software, acceptance of the Mission Control Center integrated simulation system, and completion of a Service Module hot fire launch abort test.

In late 2016, we will complete the formal NASA delivery milestone, ISS Design Certification Review (DCR), where we will demonstrate that our transportation system and operations meet all requirements, as defined in NASA's governing requirements documents [CCT-REQ-1130, ISS Crew Transportation and Services Requirements Document, and SSP 50808, ISS to Commercial Orbital Transportation Services (COTS) Interface Requirements Document (IRD)]. Successful completion of this milestone paves the way for our Flight Test Readiness Reviews.

We're on track for a pad abort test in early 2017, where we'll fully check the abort system as well as our uncrewed orbital flight test in spring 2017. The crewed flight test, which will have one Boeing test pilot and one NASA astronaut, will be in summer 2017. Test Readiness Review milestones precede both the orbital and crewed flight tests.

Following the crewed flight test, we will complete the Operational Readiness Review and Certification Review milestones in the fall. After we successfully achieve human rating Certification in the Certification Review, then the first services mission can begin as early as the end of 2017.

4. Development program challenges and risk mitigation

Like all development programs, the Commercial Crew Program presents a number of challenges, both technical and programmatic, which we are working proactively to mitigate. 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.

Our final proposal submittal assumed an August 1st authority to proceed. The award date in September followed by the stop-work order due to the protest has created schedule pressures that our team is actively working to mitigate. We actively manage numerous Technical Performance Measures to ensure compliance with design requirements. An important aspect of our management approach is opportunity management. Risk management, done well, provides the benefit of achieving technical, schedule, and cost baselines. Our team puts the same focus on opportunity management, which provides the benefit of better-than-planned technical, schedule, and cost baselines. Our team has identified dozens of opportunity targets actively in work that will provide the benefit of improved technical and schedule performance.

We are currently at the peak of our development profile, manufacturing flight design hardware in support of component, system, and vehicle-level qualification testing. Adequate yearly funding is required to maintain our current cost and schedule baselines. Appropriations levels below the presidential budget request could significantly impact overall program cost and schedule.

As we work to expand the business base beyond the International Space Station, appropriate liability protections will be necessary to foster the market. We support a cap on liability for operators against Space Flight Participant legal claims for bodily injury, similar to liability caps that exists today to facilitate

the growth and expansion of many other industries. In fact, other transportation industries--such as the shipping, railroad, and aviation industries--currently benefit from statutory liability limitation.

In today's space transportation industry, under the CSLA regulatory regime, payload owners are required to waive legal claims against launch providers. We believe a similar construct, wherein a space flight participant shares the inherent risk of space flight with the operator through limitation of damages he or she may collect in the result of accident, simply makes sense. We must not allow potential legal claims to have a chilling effect on industry growth; to do so could force this new and exciting industry overseas. Implementation of a reasonable limit on financial recovery, rather than outright elimination of legal recourse, strikes a meaningful balance between the rights of space flight participants and facilitation of an emerging industry.

Closing

Commercial transportation to low-Earth orbit is the right solution to enable a robust portfolio of NASA programs in science and human space flight. The Commercial Crew program decreases transportation cost for our astronauts, increases our American space workforce and frees up funding for NASA to invest in deep space exploration.

Boeing is making strong progress in a rigorous development effort. Boeing is bringing the same quality to commercial space flight that that we bring to our servicemen and women, NASA astronauts and to the traveling public, every day. Thank you.

Thank you again for the opportunity to be here today.