National Aeronautics and Space Administration

Commercial Crew Program Status

NAC HEO Committee
July 2015

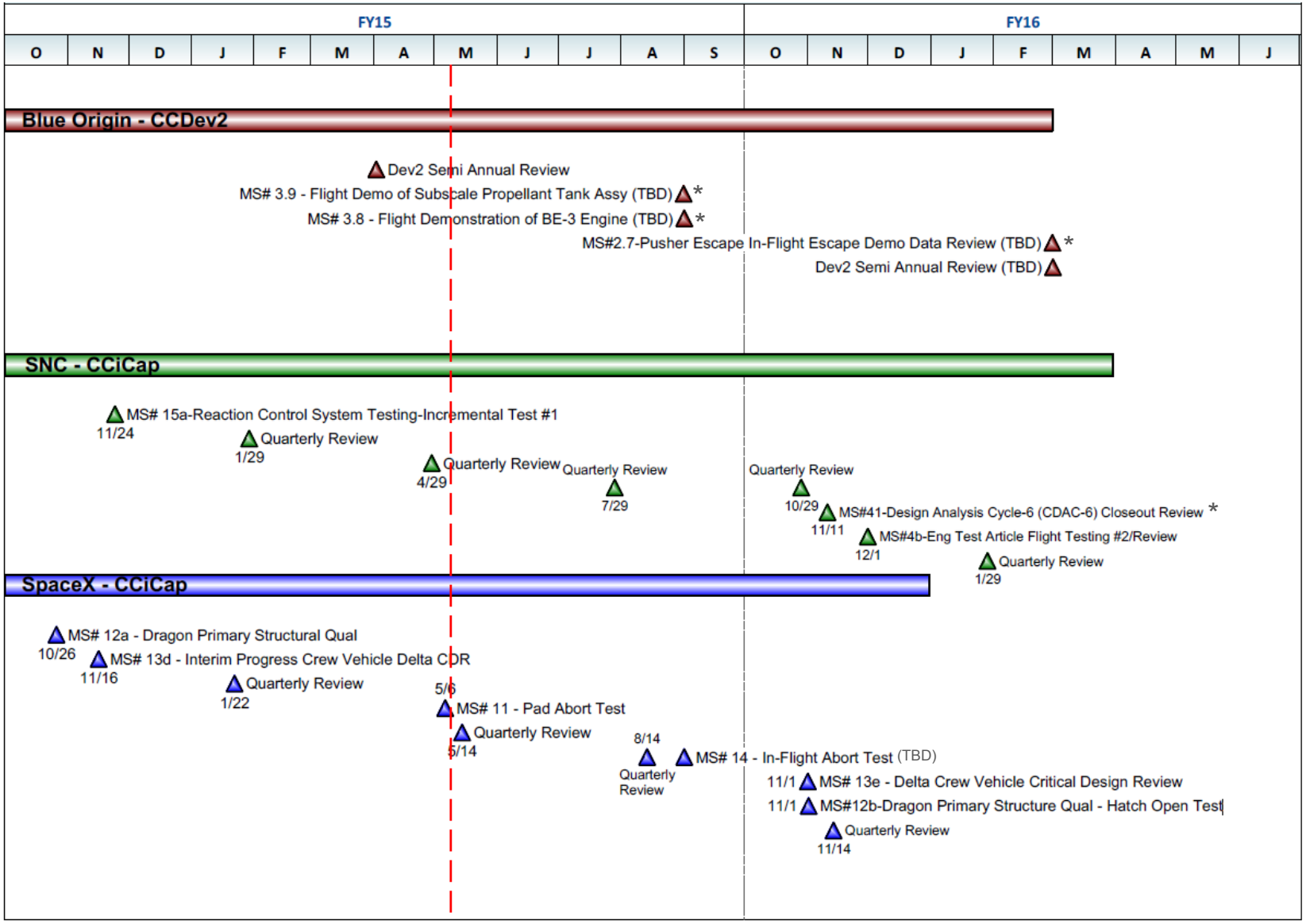
Overview

- **The Commercial Crew Program (CCP) is an essential element of the the broader strategy to achieve our nation's goals in space.**
- **CCP will re-establish the capability to launch astronauts from US soil.**
- **CCP will increase the ISS crew time available for research by an amount equivalent to one additional astronaut dedicated to research.**
  - This is critical to accomplishing the human research required for deep space exploration during the lifetime of ISS
- **Commercial transportation is vital to expanding the commercial market for low Earth orbit services, enabling NASA and its international and commercial partners to extend human presence into the solar system and to the surface of Mars.**

Agenda

- **Space Act Agreement Status– CCDev2/CCiCap**
- **CCtCap Partner Status**
  - Schedule
  - Technical Description of System
  - Recent Partner Accomplishments
- **Budget**
- **Additional Activities and Forward Work**
- **Summary**

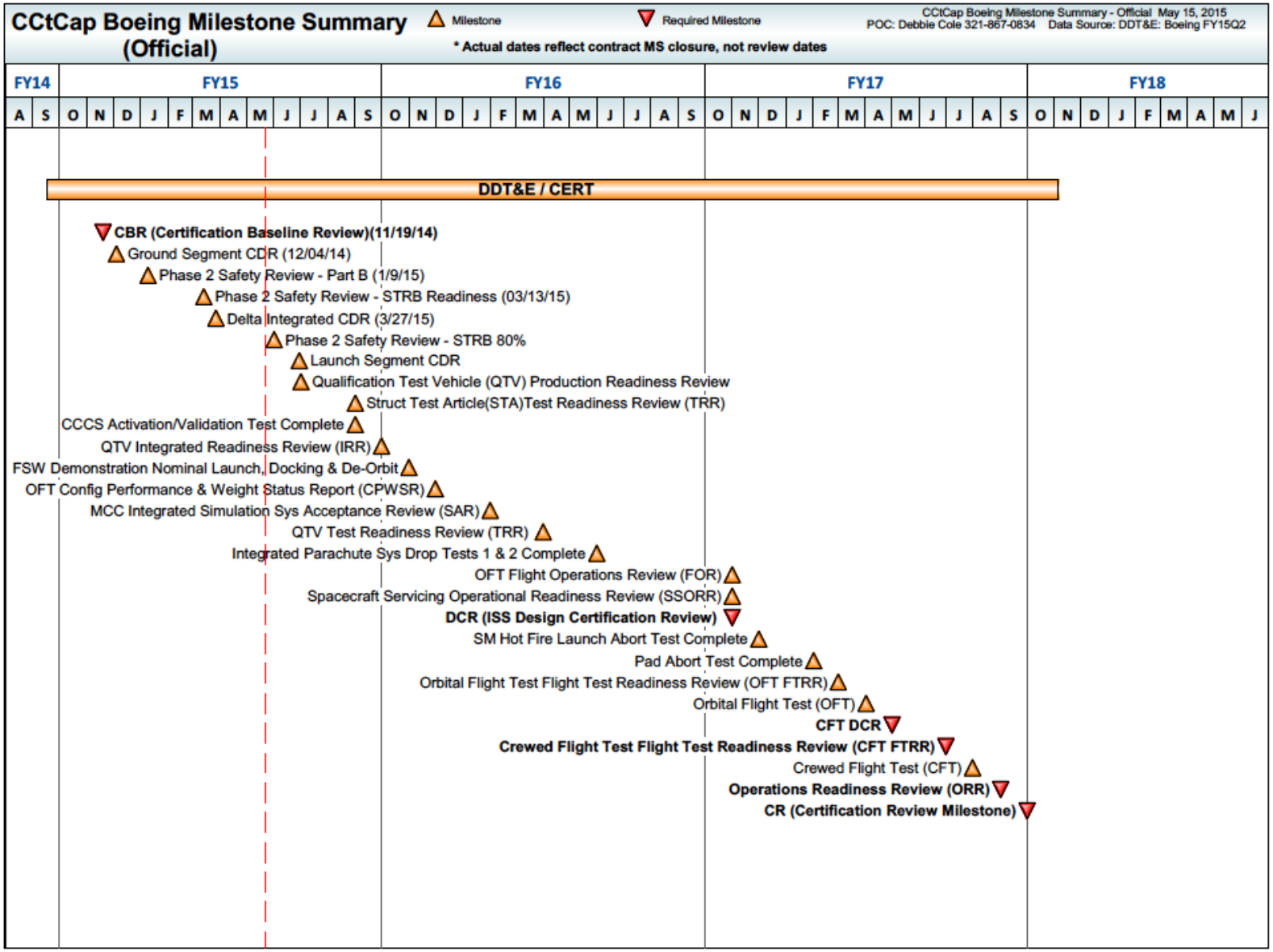
Space Act Agreement Milestone Summary



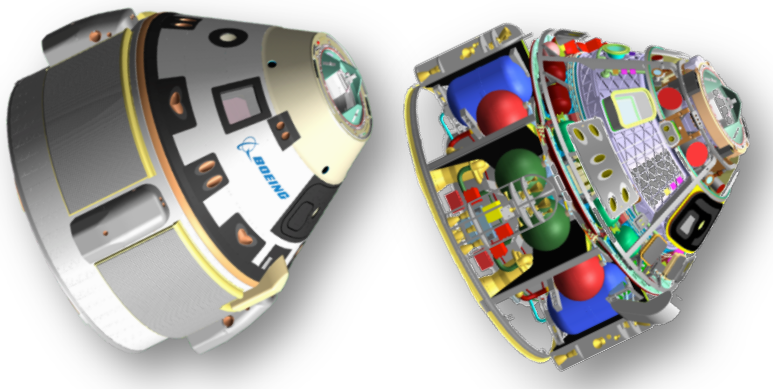
* Unfunded Milestone

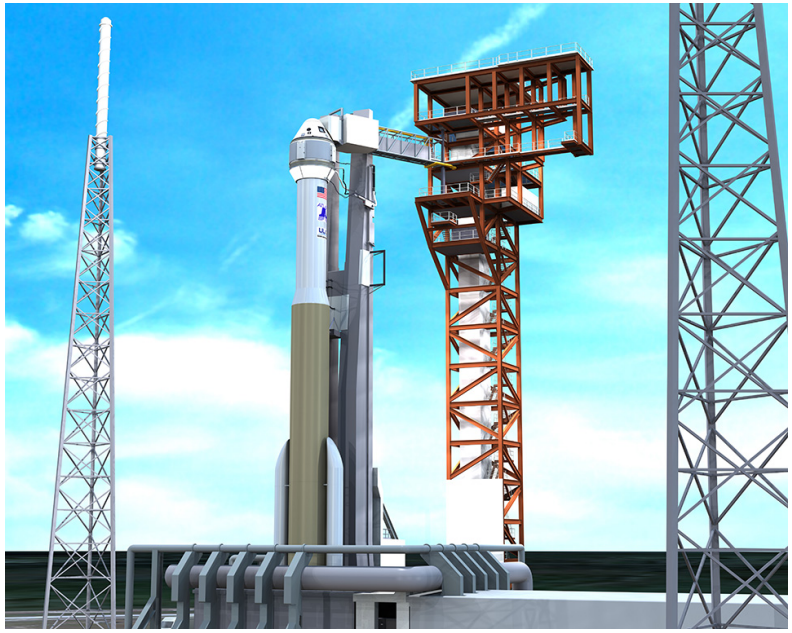
Boeing CCtCap Status

Boeing Schedule Overview



Boeing System Overview





Boeing's Crew Space Transportation (CST) -100 spacecraft can accommodate up to seven passengers, or a mix of crew and cargo to low-earth orbit destinations such as the International Space Station or the Bigelow planned station. The system is comprised of the CST-100 spacecraft, Atlas V launch vehicle, and associated ground infrastructure.

Spacecraft Features

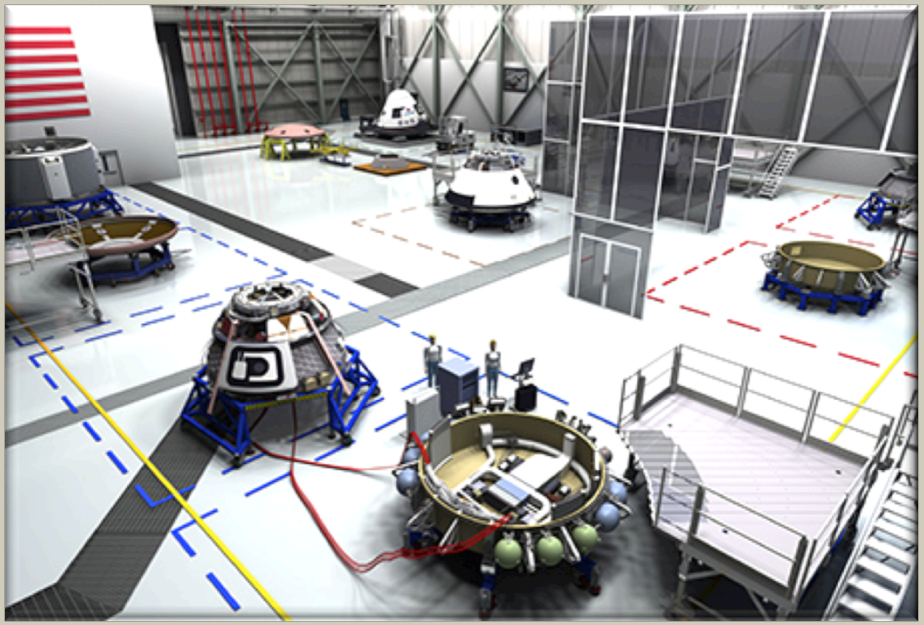
- Weld-free capsule
- Tablet technology
- Boeing Sky Interior lighting
- Liquid-propelled pusher abort system
- Automated docking system
- Parachute and air bag system for soft land landings

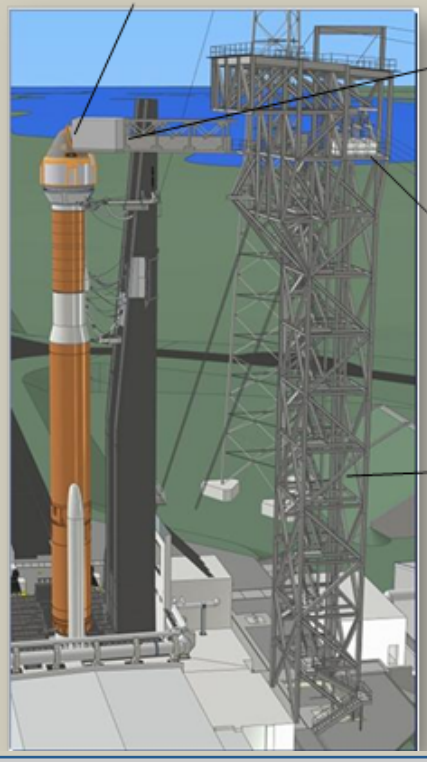
Launch Vehicle Features

- Proven Atlas V rocket with emergency detection system, providing real time launch vehicle health monitoring and providing the earliest warning of impending catastrophic launch vehicle failures.

Boeing Ground Segment Features

- Boeing is in the process of modifying LC-41 for crewed launches
- Kennedy's Processing Control Center will be used for Boeing Mission Operations in addition to Johnson Space Center mission control
- Orbiter Processing Facility-3 (OPF-3) will be the hub of CST-100 processing
  - Shuttle infrastructure removed
  - High and low bays modernized for a clean factory system layout
  - More than 150 pieces of hardware currently inside for spacecraft production





Boeing Accomplishments To Date

- Phase 2 Safety Review milestones completed
- Conducted Delta Integrated Critical Design Review milestone
- Completed Structural Test Article Design Review
- Orbital Flight Test Vehicle Mission Integration Kickoff
- Several component design reviews conducted
- Multiple TIMs and other meetings held with NASA to provide insight

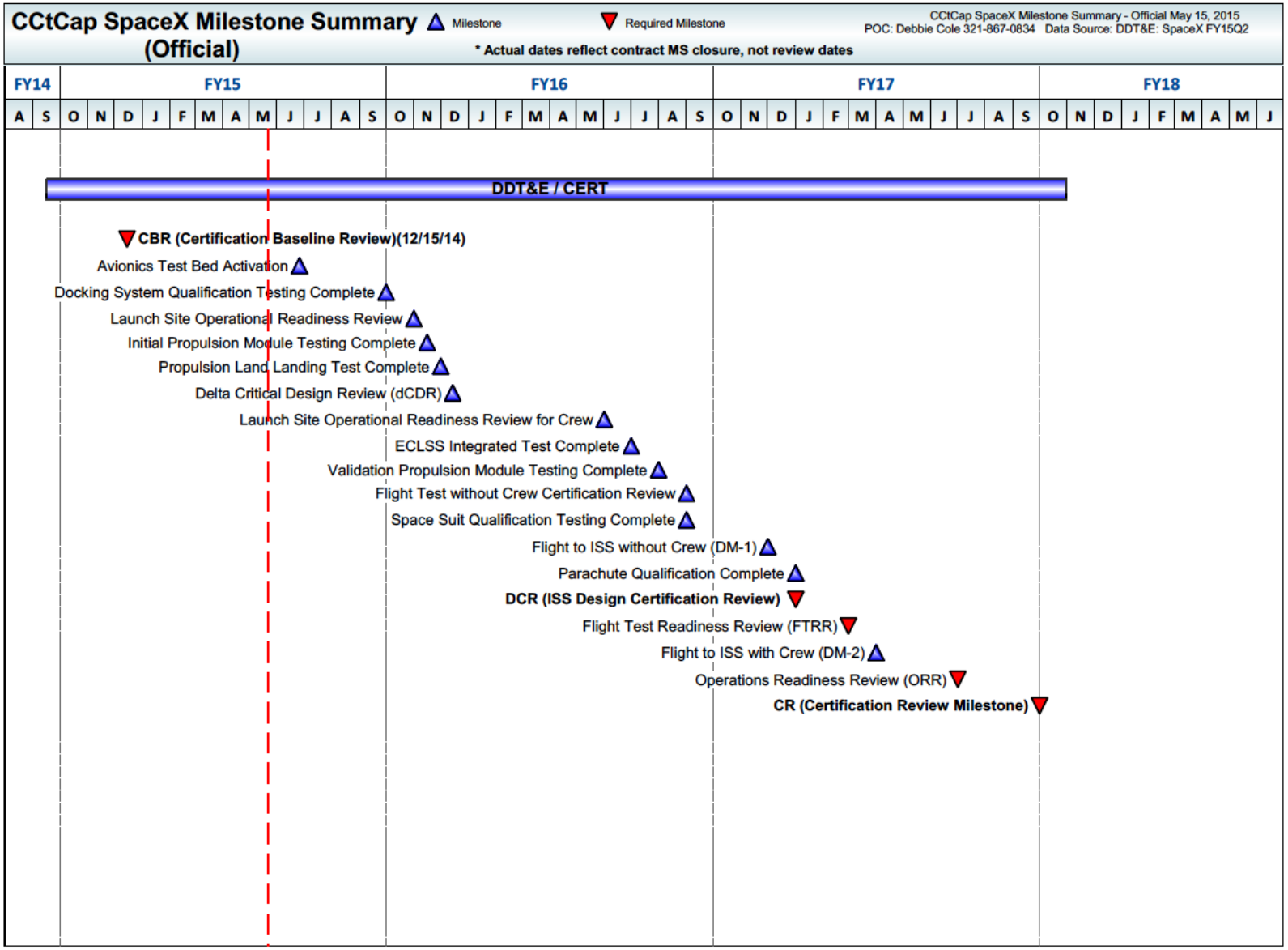
SpaceX CCtCap Status

SpaceX Accomplishments To Date

Pad Abort Test

- Quick Look test report presented to NASA on May 18. Full report due in 60-90 days.
- There were over 200 sensors onboard the test capsule as well as numerous cameras and a simulated crewmember.
- The test demonstrated the effectiveness of the Crew Dragon launch abort system and the data collected during the test is being used to confirm analysis models and inform and mature the final spacecraft design.
- Milestone payment approved by NASA.

SpaceX Schedule Overview



System Description

SpaceX Architecture Description

- **Spacecraft Segment (Dragon)**
  - Crew & Cargo Module
  - Service Module (Trunk)
  - Launch Abort System (internally integrated in Dragon, Ethernet interface to F9)
- **Launch Segment (F9)**
  - Full thrust Merlin engines
  - Densified propellants (chilled LOX & RP-1)
  - F9 first stage w/ Falcon Heavy strap-on booster
  - Autonomous Flight Termination System
  - Stowed stage recovery hardware (landing legs, grid fins)
  - Additional pusher to guide full thrust nozzle during stage separation
- **Ground and Operation Segment**
  - Launch Operations System
    - Launch Pad (LC39A), Launch Pad facility, Ground SW, & Launch Control Center
  - Mission Operation System
    - MCC (Hawthorne) Crew Ops, Training & Sim, & Recovery

Crew Dragon Vehicle

Falcon 9

Mission Control in Hawthorne, CA

Launch Control Cape Canaveral, FL

LC-39 Cape Canaveral, FL

Spacecraft Segment (Dragon) Features

Dragon & Trunk Assembly

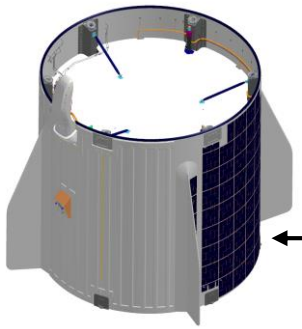
Nose Cone

Pressure Section

Service Section (unpressurized)

Crew Seats and Touch Screen Displays

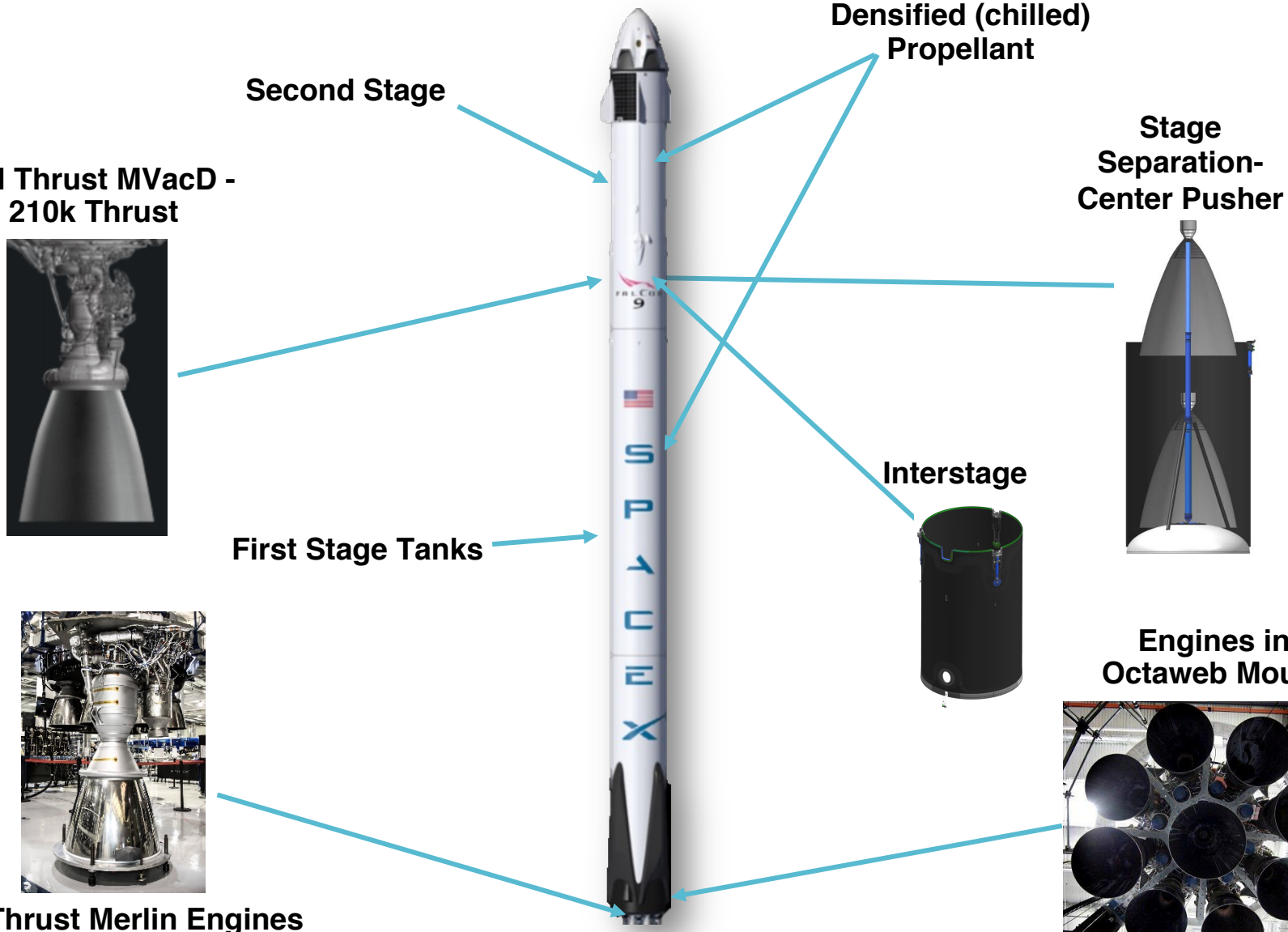
Super Draco Pod



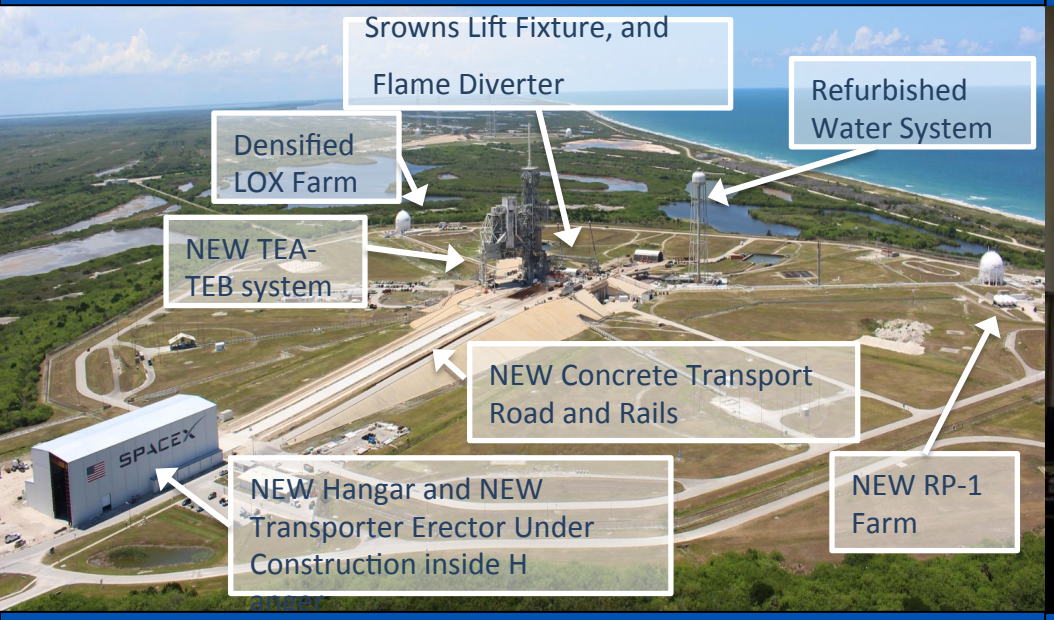
Trunk (unpressurized)

Conformal Solar Arrays

Launch Segment (F9) Features



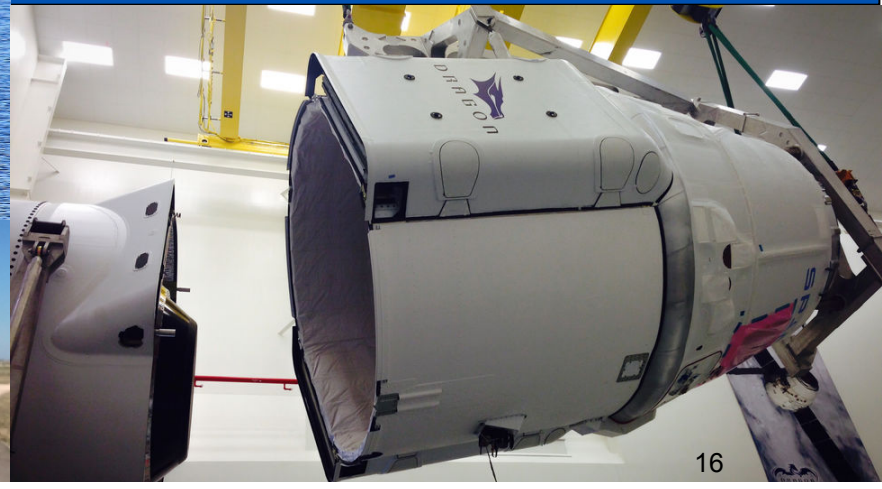
SpaceX Ground Segment Features



Hawthorne Mission Control Center

Water landing recovery and transport

Crew Dragon Processing Facility



SpaceX Accomplishments To Date

- **Baseline update**
  - Certification Baseline Review and Water Landing con ops changes require maturation of Dragon/Falcon system design in order for SpaceX to be ready for delta CDR milestone in December 2015.
- **Avionics Test Bed Activation milestone completed**
- **Insight activities into updated baseline**
  - Established over 30 insight forums to increase insight
  - Held numerous TIMs and meetings
  - Established Crew Capability Working Group to assess Crew Dragon's level of automation.

Additional Activities and Forward Work

- **Initiating Post Certification Mission (PCM) activities**
  - CCP has authorized first PCM from Boeing
  - The authorization was timed to allow for PCM launch by December 2017
  - CCP plans to authorize first PCM from SpaceX later this calendar year, also allowing for PCM launch by December 2017
- **Finalizing framework for Certification of Flight Readiness**
  - The framework will be incorporated into the first revision of CCT-PLN-2100 CTS Certification of Flight Readiness (CoFR) Plan
- **Baseline Mishap Preparedness and Contingency Plan (MPCP) for Commercial Crew Program (CCT-PLN-1010)**
  - Draft Mishap Plan sent out for formal review and comments received. Baselining expected by the end of July/early August.

Budget Status

- **NASA FY2016 President's Budget Request for CCP is $1.243B.**
  - Fixed price, FAR-based contracts are in place
  - Both companies have demonstrated good progress and performance
  - Ending U.S. reliance on Russia for crew transportation is a priority

- **While some CCtCap milestones may move from FY 2016 to FY 2017, this does not correspond to a reduction in NASA's FY 2016 funding requirements from the President's Budget Request.**

- **Milestones must be funded (obligated) prior to the contractor beginning work on the milestone.**

- **At this point, and given all the current milestone changes, NASA still requires the full CCP President's Budget Request for FY 2016.**

Budget Implications

- **Near-Term**
  - If the Agency is funded with a Continuing Resolution for the first quarter of FY 2016, NASA will need to address how it will fund our partners' development activities at the current contractual schedule.

- **Longer-Term**
  - If NASA does not receive sufficient funds in FY 2016 to maintain the current schedules, the contractors will have to stop work or work at risk until additional funding can be obligated.
  - In that case, the existing CCtCap contracts will need to be renegotiated, most likely resulting in schedule delays and increased contract costs.
  - NASA will need to continue to rely on Russian Soyuz capability to meet America's requirements for crew transportation services.

- **NASA has no plans to downselect the number of partners in response to lower-than-requested funding levels. As experience has shown with cargo, NASA's plan to establish a redundant crew transportation capability is critically important for robust, safe ISS operations.**

Summary

- **CCP remains committed to supporting our Space Act Agreement partners as they advance their concepts**
- **Both Boeing and SpaceX are advancing their CCtCap designs**
- **Hardware is actively being built and tested to inform design**
- **CCP is engaged in meaningful insight with the providers**
- **Important design challenges remain for both providers**
- **CCP is preparing for the flight phases of the program**

SpaceX: Pad Abort Test Static Test Firing

Boeing: Test 1 Water Landing and Rotation to Stable 2

CCP is now at the point where all the preliminary work through the previous phases of the program is all paying off, and our two partners are off and running with effective NASA insight/oversight. We need to keep up the momentum with adequate funding to achieve safe, reliable, and cost effective commercial crew transportation services.