



Commercial Crew Program Status ***NASA Advisory Council HEO Committee***

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Purpose & Agenda



- **Purpose: To brief the HEO NAC on the current status of the CCP CCtCap and CCiCap contracts**

Agenda:–CCP Execution Status

Program Progress

- **Flight Test Planning**
- **Inter-Agency Collaboration**
- **Program Risks–CCtCap Status**
- **Boeing Commercial Provider Status**
- **SpaceX Commercial Provider Status**
- **–CCiCap Status**
- **CCiCap Milestone Schedule**
- **Blue Origin Status**
- **Sierra Nevada Corp. Status**
- **Summary**



Program Progress



CCP has made significant progress over the last quarter, notably:

Awarded Post Certification Missions 3 - 6 for both providers in December 2016

Continue to burn down key certification products with the providers

- Progress for each provider is included in provider-specific sections of this briefing

Eight CCP missions now in process:

- For SpaceX:
 - November 2017: Flight to ISS Without Crew (Demo Mission 1)
 - May 2018: Flight to ISS with crew (Demo Mission 2)
 - PCM-1 awarded November 2015; Completed three milestones to date
 - PCM-2 awarded July 2016; Completed one milestone to date
- For Boeing:
 - June 2018: Orbital Flight Test (unmanned demo)
 - August 2018: Crewed Flight Test (demo)
 - PCM-1 awarded May 2015; Completed five milestones to date
 - PCM-2 awarded in December 2015; Completed four milestones to date



Flight Test Planning & Status



Refining Flight Test Mission Definition

- Determined the CTS requirements to be closed prior to each flight test
 - Verification Closure Notice (VCN) applicability approved for both providers
- Evaluating Flight Test Objectives received from the providers
 - Focused on delineation of pass/fail criteria and decomposition of Primary and Secondary Objectives
- Defining NASA Certification of Flight Test Readiness (CoFTR)

Defining CCP/Provider/ISS Interactions

- All flight tests will dock with the ISS; necessitates strong tri-lateral integration (ISS, CCP, Providers)
 - Examples include: Cargo up-mass and down mass; International partner data exchange and training, ISS Services for the providers

Building Mission Management Strategy

- Starting work to understand NASA management and technical support for the missions; includes pre-launch, launch, orbit, and landing
- Will define overall mission management structure and determine NASA/provider interaction
- Includes both strategic decision making process and detailed discussions, e.g., day of launch



Inter-Agency Collaboration



NASA CCP is collaborating with multiple agencies to facilitate U.S. commercial crew space transportation, examples include:

- FAA
 - Established NASA/FAA Memorandum of Understanding
 - Developing cross waiver approach for government payloads
 - Facilitated addition of Government Astronaut into FAA statutes
 - Providing input into FAA Government Astronaut Guidelines
- FCC and NTIA
 - Coordinating an approach for commercial spectrum usage and authorization
 - Agreed upon FCC assessment of commercial provider compliance for orbital debris mitigation
- Air Force and Eastern Range
 - Synergizing certification efforts
 - Partnering on simulations for search and recovery operations
- NASA, FAA, and USAF
 - Established the Launch and Entry Steering Group (LESG) which provides a forum for all three agencies to work through issues of mutual interest, including policy and strategy issues that will affect commercial crew



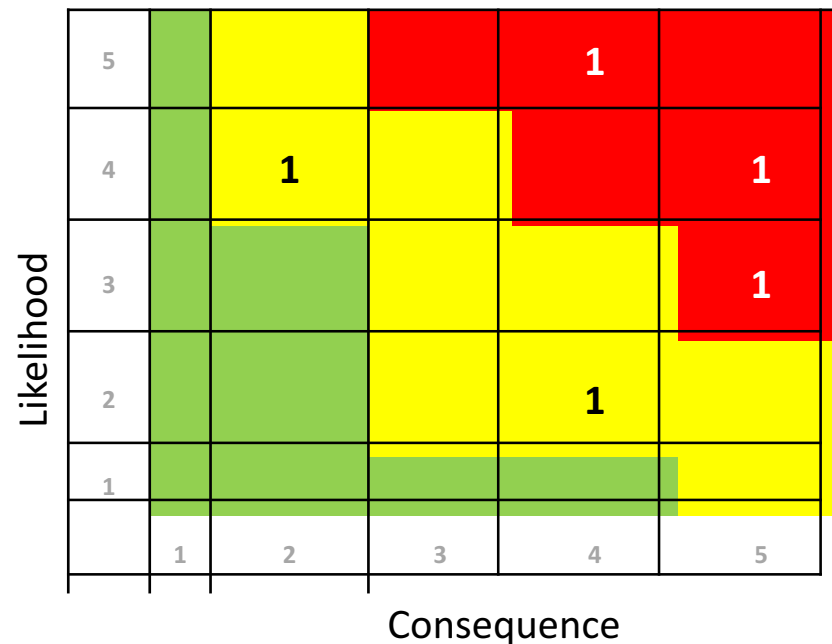
CCP Top Programmatic Risks

2/7/17



LxC	Trend	Risk Title	Risk ID Number	Office
4x5	NC	Requirement Changes	CCP-PCI-2015-3	PC&I
5x4	NC	DOD Search and Rescue Posture	CCP-GMO-2015-3	GMO
3x5	NC	Ability to Close the LOC Gap	CCP-SEI-2015-1	SE&I
4x2	D	Ammonia Emergency Response	CCP-SC-2016-3	SC
2x4	D	DoD Search and Rescue Training Schedule	CCP-GMO-2015-4	GMO

Trend Key: NC = No Change, I = Increase in Risk, D = Decrease in Risk



NOTE: “Programmatic” risks include cost, schedule and technical consequences



CCP Top Program Safety Risks

2/7/17



LxC	Trend	Risk Title	Risk ID Number	Office
3x5	NC	Ability to Close the LOC Gap	CCP-SEI-2015-1	SE&I
3x3	New	Crew Entry Environment and Intracranial Hypertension and VIIP injury	CCP-IP-2016-3	IP
1x5	New	Ammonia Emergency Response	CCP-SC-2016-3	SC
1x5	New	Aborting into Sea States with Unsafe Rescue	CCP-GMO-2016-3	GMO

Trend Key: NC = No Change, I = Increase in Risk, D = Decrease in Risk

5					
4					
3			1		1
2					
1					2
	1	2	3	4	5

Consequence



Boeing Accomplishments



Design

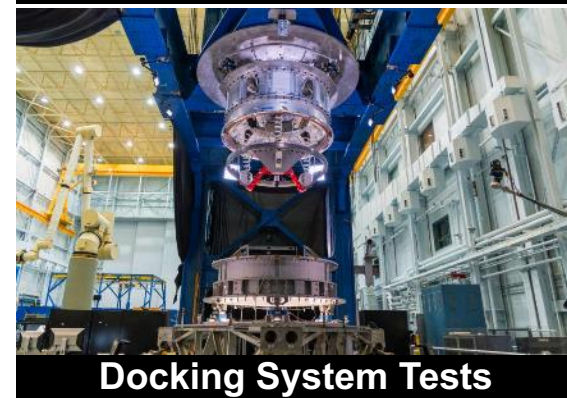
- Ascent & Entry Suit CDR complete
- Base Heat Shield CDR complete

Demonstration & Test

- Wind Tunnel Testing of Launch Vehicle Adapter skirt design tested
- International Docking Adapter and NASA Docking System tested at Johnson Space Center
- Successful drop test for parachutes and deployment sequence
- Launch Abort Engines (LAEs) with new propellant valves hot-fire development testing complete
- RL10 hot-fire acceptance testing of CFT engines complete
- Landing airbag qualification testing at Langley Research Center complete
 - Additional tests scheduled to validate crew impacts



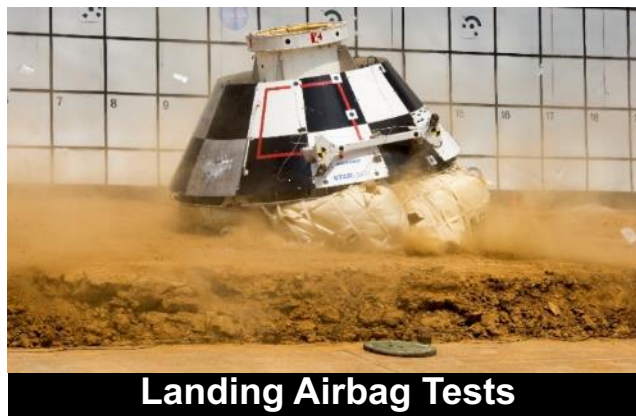
A/E Suits



Docking System Tests



RL10 Acceptance Tests



Landing Airbag Tests



Landing Airbag Tests



Boeing Accomplishments

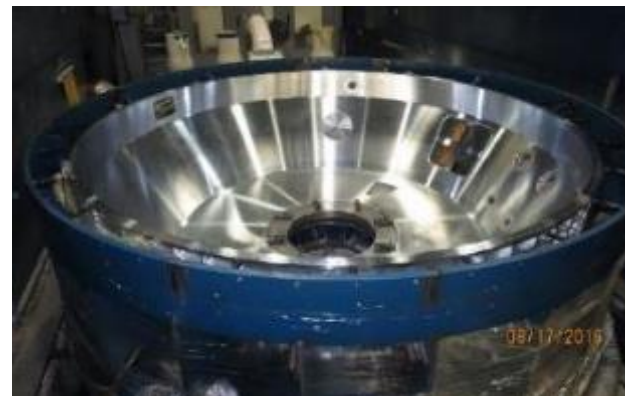


Production & Qualification

- ER 8.0 S/W release
- Structural Test Article (STA) shipped to Huntington Beach for testing
 - Proof Pressure Test completed in December
- Spacecraft 1 Crew Module upper and lower dome outfitting in work for "power on"
- Spacecraft 1 Service Module structural panels at Kennedy Space Center
- Service Module Hot Fire test vehicle in production
- Spacecraft 2 upper and lower dome outfitting has begun in C3PF
- Spacecraft 3 progressing across supply base

Facility Preparations

- Boeing Mission Simulator delivered to JSC in Houston
- Work progressing at White Sands Test Facility
- C3PF Hazardous Processing Facility blast doors installed



Spacecraft 2



STA in Pressure Test Cage



Boeing Mission Simulator

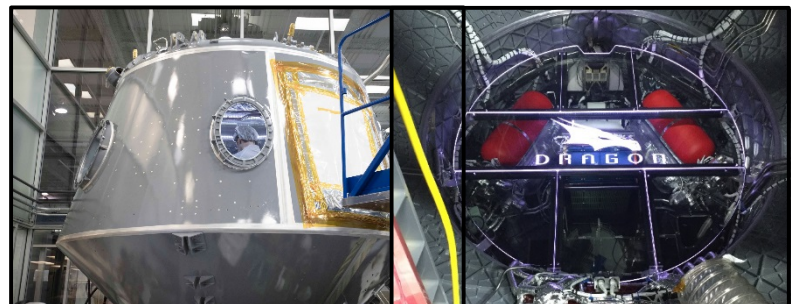


SpaceX Accomplishments



Design

- Dragon
 - Validation propulsion module design review complete
 - Continuing to partner open items in support of design implementation closure
- Life Support and Space Suits
 - Completion of ECLSS system testing and successful suit milestone testing in Q4 CY2016 provides confidence that designs are closing and on a good trajectory for cert/qual
- LC-39A
 - Crew access arm and white room critical design reviews complete
 - LC-39A Design Reviews Completed including (but not limited to) fluid systems, environmental control systems, emergency egress system, and hydraulics upgrades
- F9
 - Merlin 1D and MVAC design review held
 - Continuing to partner Falcon 9 block upgrades in support of design implementation closure



Life Support



Merlin 1D Full Thrust



LC-39A



SpaceX Accomplishments



Demonstration & Test

- LC-39A crew egress demonstration on Crew arm as part of LSORR2
- Completed LC-39A activation testing in preparation for launch of CRS-10
- Parachute weighted sled and shaped test article drop test campaign is ongoing
 - 6 drops, 2 weighted sleds and 4 shaped test articles complete to date
- On track to upgrade Buck in support of interior functional fit checks (JTT)
- HITL table assembled in support of software testing evolving as ORU's are populated
- F9-30 return to flight from VAFB and F9-32 first launch from LC-39A

Production & Qualification

- 4 Dragon Modules in production: Qual Module, DM-1, DM-2, & ECLSS Module
 - Qual module structural testing in work
 - DM-1 service section integration in work. Completion planned Q1/Q2
 - ECLSS module 4 humans in the module test complete and off gassing test complete.
 - DM-2 weldment completion planned Q1/Q2



Dragon 2 Weldment and Heatshield



Parachute Test Drop



POC: Emily Weiland 321-867-4052

Data Source: CCP SAA Milestone FY17Q1. Updated 02/16/17

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Sierra Nevada Corp. Accomplishments



Approach & Landing Test 2 (ALT-2) is CCIcap Milestone 4B

- Full scale Dream Chaser® engineering test article (ETA) unpowered approach & landing test (ALT-2) at Armstrong Flight Research Center
 - Primary Objectives:
 - Collect subsonic aerodynamic data to validate wind tunnel and CFD aero results
 - Validation of spacecraft low-speed aerodynamic flying qualities – stability and control
 - Validate subsonic orbital vehicle flight software and GN&C functionality.



Key Dream Chaser® test vehicle Activities, Q3 2016 - Q1 2017

- Successfully executed a large number of offline, on-vehicle and integrated tests in Louisville, CO facility to verify system design requirements and validate system function.
 - Avionics Checkout with Flight Fault Tolerant Flight Computers using Flight Software
 - Landing Gear Deploy System successfully tested
 - Polarity Test, Multi-Actuator Test, pre-Ship Day-In-The-Life Test, Radar Altimeter installs, Flush Air Data System Checkout, Rollout Ground Resonance Test
- ETA shipped departed Louisville, CO on Fri. 20 Jan. and successfully received at AFRC/EAFFB on Wed. 25 Jan.
 - ETA reassembled and configured for systems testing
 - Wings, rudder, flight actuators installed
 - Integrated System Testing at AFRC
 - Post-ship FSW regression testing, Post-ship Day in The Life (DITL) & DITL RF test, Airborne Ground Resonance Testing (GRT), 20/40/60 MPH Tow Testing, Moments Of Inertia (MOI) Testing, Airborne Gain Margin Test (GMT)
 - ETA Captive Carry Test (w/Erickson Skycrane Helo)



ETA Approach and Landing Test 2 (ALT-2) – June 2017

- Associated CCIcap milestone 4B – July 2017





Blue Origin Accomplishments



Commercial Space Capabilities
Collaboration (CSCC) Unfunded
Space Act Agreement (SAA)

Accomplishments

- Technical Interchange Meetings
 - Thermal Protection System Facility (TPSF tour KSC)
 - Navigation Development (GSFC)



New Glenn public unveiling at Satellite2017

Data Exchange

- Various software requests and technical documentation exchange in work.

Look Ahead

- Milestone Review #3, Progress Review of *New Shepard* Subscale Crew Transportation System, scheduled for May at Blue Origin's Kent, Washington facility
- High Altitude Parachute Deployment Lessons Learned TIM
- Continuing technical interchange



CCP Summary



CCiCap partners continue to advance integrated crew transportation system designs

CCtCap partners, Boeing and SpaceX, are meeting contractual milestones and maturing their designs

- Actively building and testing hardware to inform design
- Engaging in meaningful insight with NASA
- Addressing important design challenges

Providers are providing increased insight opportunities for the NASA team

CCP has robust and efficient processes for certification including addressing waivers and deviations

In preparation for flight, there is significant work ahead



