



# **Commercial Crew Program Status**

## ***NASA Advisory Council HEO Committee***

**Kathryn Lueders**  
**Manager, Commercial Crew Program**

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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



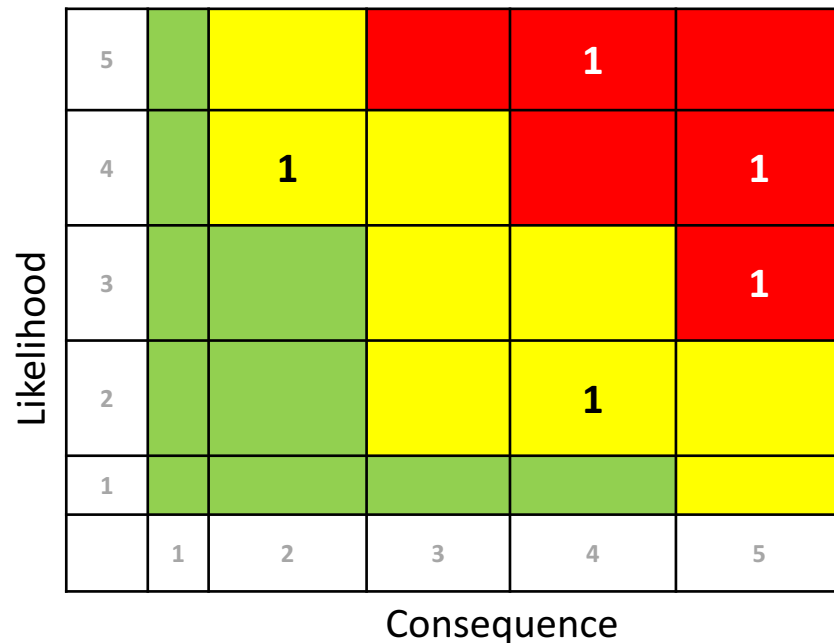
# CCP Top Programmatic Risks

## 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	Green	Yellow	Red	Red	Red
4	Green	Yellow	Yellow	Red	Red
3	Green	Green	1 Yellow	Yellow	1 Red
2	Green	Green	Yellow	Yellow	Yellow
1	Green	Green	Green	Green	2 Yellow
	1	2	3	4	5

Likelihood

Consequence



# Boeing Accomplishments



- **Design**

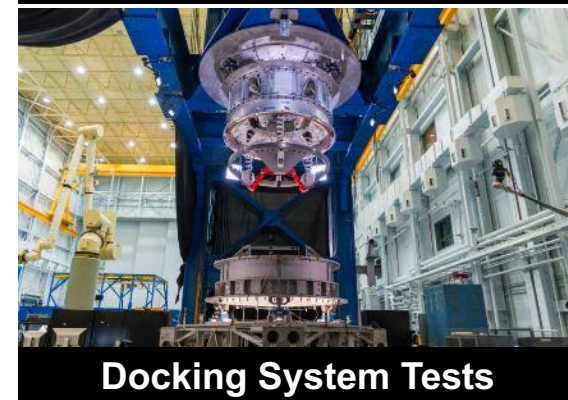
- Ascent & Entry Suit CDR complete
- Base Heat Shield CDR complete

- **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



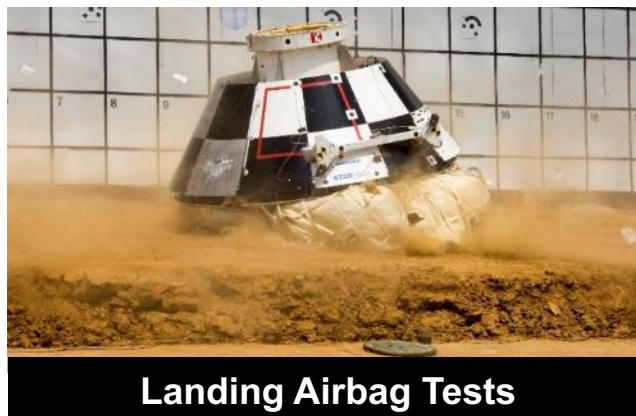
**A/E Suits**



**Docking System Tests**



**RL10 Acceptance Tests**



**Landing Airbag Tests**



**Landing Airbag Tests**



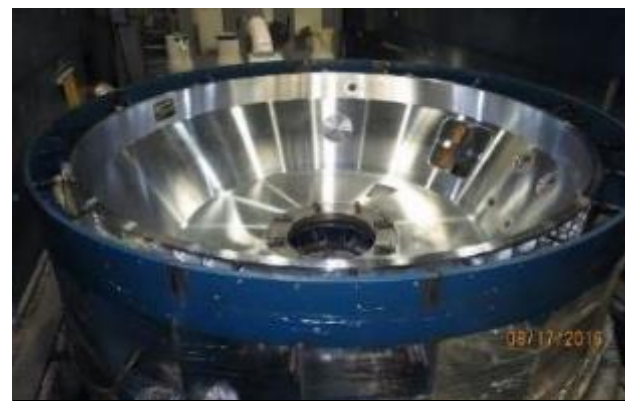


# Boeing Accomplishments



- **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



**Spacecraft 2**

- **Facility Preparations**

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



**STA in Pressure Test Cage**



**Boeing Mission Simulator**

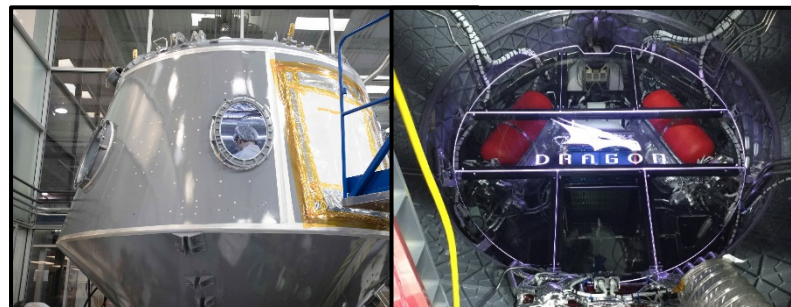


# SpaceX Accomplishments



- **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**





# CCiCap Combined Milestone Summary



CCiCap/CCSC Milestones (Official)																	CCiCap/CCSC - Official FY17Q1 POC: Emily Weiland 321-867-4052 Data Source: CCP SAA Milestone FY17Q1, Updated 02/16/17																														
FY15					FY16					FY17					FY18																																
O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
<b>Blue Origin</b>																	Planned Completion: 4/2021																														
4/2 ▲ Dev2 Semi Annual Review																	3/1 ▲ Dev2 Semi Annual Review																														
																	4/15 ▲ CSCC No Funds Exchanged SAA signed																														
Progress Review of the Subscale Propellant Tank Assembly ▲ 11/1																	Progress Review of Subscale CTS ▲ 5/1																														
																	Progress Review of Rocket Propulsion Systems ▲ 11/1																														
																	Development Update of Launch Site ▲ 5/1																														
<b>SNC - CCiCap</b>																																															
11/24 ▲ MS# 15a-Reaction Control System Testing-Incremental Test #1																	7/27 ▲ Quarterly Review #14																														
1/29 ▲ Quarterly Review #9																	10/13 ▲ Quarterly Review #15																														
4/29 ▲ Quarterly Review #10																	1/12 ▲ Quarterly Review #16																														
8/20 ▲ Quarterly Review #11																	4/12 ▲ Quarterly Review #17																														
12/17 ▲ Quarterly Review #12																	7/12 ▲ Quarterly Review #18																														
4/7 ▲ Quarterly Review #13																																															
<b>SpaceX - CCiCap</b>																																															
11/24 ▲ MS# 12a - Dragon Primary Structural Qual																																															
12/22 ▲ MS# 13d - Interim Progress Crew Vehicle Delta CDR																																															
1/22 ▲ Quarterly Review																																															
5/29 ▲ MS# 11 - Pad Abort Test																																															
5/14 ▲ Quarterly Review																																															
8/14 ▲ Quarterly Review																																															
11/16 ▲ Quarterly Review																																															
12/15 ▲ MS# 13e - Delta Crew Vehicle Critical Design Review																																															
6/9 ▲ MS#12b-Dragon Primary Structure Qual - Hatch Open Test																																															



# 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.



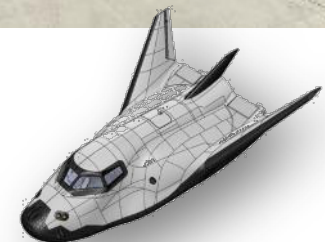
- **Key Dream Chaser® test vehicle Activities, Q3 2016 - Q1 2017**

- 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**



