

A composite image showing the Orion spacecraft and the Space Launch System (SLS) rocket in space. The Orion spacecraft is on the right, with its solar panels deployed. The SLS rocket is on the left, with its orange external tank and white boosters. The background is the Earth's surface and the blackness of space.

Exploration Systems Development Update

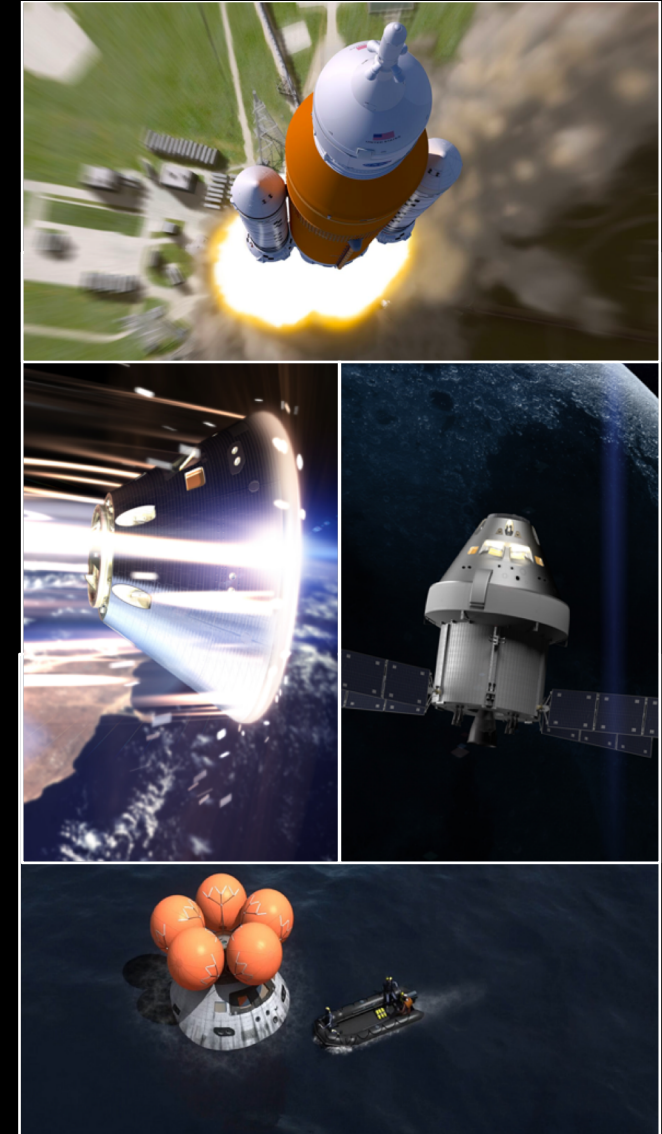
Bill Hill, Deputy Associate Administrator for
Exploration Systems Development

NASA Advisory Council (NAC)
May 28, 2019

Artemis 1 Priorities that will enable NASA to fly crew to the Moon and back on Artemis 2:

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1. Demonstrate Orion heatshield at lunar entry velocities
 - a. Validate required system performance that is mandatory to support crewed missions, which can only be achieved in actual flight environment
 - b. Demonstrate SLS ascent and launch vehicle operations including ascent separation events
2. Operate Systems in Flight Environment
 - a. Demonstrate Orion deep space environmental performance, communications, propulsion, and navigation systems
 - b. Demonstrate EGS ground systems and day of launch operations and support EGS Recovery forces positioning if possible
 - c. Demonstrate Flight Operations management, execution, network management of Near Earth Network, Space Network, and Deep Space Network and facilities support systems
3. Retrieve Spacecraft
 - a. Retrieve Orion crew module including onboard only recorded Development Flight Instrumentation, onboard recorded imagery/video, avionics for re-flight
 - b. Position assets and demonstrate capsule recovery operations when supportable



Artemis 1 Priorities (continued)

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4. Complete Remaining Objectives: Perform residual mission in the absence of system failures and conduct all mission content as planned
 - a. Provide lighted landing to support imagery collection during the entry, descent, and landing sequence
 - b. Complete additional time in deep space for system trending and analysis
 - c. Conduct optical navigation certification
 - d. Demonstrate redundant systems and downmode capability to the extent practical
 - e. Perform remaining ESD and Program Flight Test Objectives and Program specific activities
 - f. Deploy secondary SLS payloads
 - g. Support public outreach



Building to Artemis 1

Exploration Systems Development Update – May 28, 2019

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European Service Module Critical Design Review	✓	LVSA Manufacturing Complete	✓	Core Stage Green Run Hot Fire Test
Crew Module Pressure Proof Test	✓	Mobile Launcher (ML) Umbilicals Installed	✓	Crew and Service Module Delivery to EGS
Booster Qualification Motor 2 Test	✓	VAC Welding Complete on Core Stage	✓	Ground Flight Application Software Complete
Crew Module Propellant Pressure Proof Test	✓	Launch Pad Flame Trench Construction Complete	✓	Booster Stacking in VAB
VAB Verification & Validation Complete	✓	Parachute Tests Complete	✓	Core Stage Arrival at KSC
RS-25 Flight Engines Complete	✓	European Service Module Delivered to KSC	✓	Core Stage Stacking with Boosters in VAB
ICPS Delivered to KSC	✓	Crew Module and Service Module Mate		CM/SM Mating with Launch Abort System
Crew Module Initial Power On	✓	All Orion Splash-down Recovery Tests Complete*		Orion Mating with SLS in VAB
VAB High Bay Construction Complete	✓	Core Stage Integration		Wet Dress Rehearsal at Launch Pad
Multi-Payload Processing Facility Construction	✓	ML Ground Support Equipment Installation Complete		Roll-out for Launch



*Known as Underway Recovery Tests – NASA and the U.S. Navy are conducting Underway Recovery Tests to verify and validate procedures and hardware that will be used to recover the Orion spacecraft after it splashes down in the Pacific Ocean following deep space exploration missions.

Schedule Risk Reduction Initiatives

Exploration Systems Development Update – May 28, 2019

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- ESD is adopting a test flight philosophy for Artemis 1 that will allow for some increased technical risk to achieve an earlier successful test flight.
- ESD implemented a revised schedule management approach to improve visibility and correlation to lower level tasks and to better account for risk in schedule projections; Orion, SLS, and EGS are evaluating improvement options.
- ESD is judiciously adjusting workforce levels to optimize the right skill sets in the right areas to address critical path issues.
- Key SLS improvements are already being implemented.
 - Placed senior government management and engineering support on-site at the Michoud Assembly Facility (MAF) to reduce decision cycle time for plant-level production and engineering decisions.
 - Brought suppliers to MAF to help resolve shortages and install resolutions.
 - Changed Core Stage process flow from a serial flow to a parallel flow, allowing for engine section outfitting in parallel with forward and aft segment assembly operations substantially improving the efficiency of the overall operations.
 - Implemented new tooling solutions to improve assembly operations.
 - Developed story boards for new work instructions, burn-down metrics for critical Engine Section installations, and metrics for supplier shortages to Engine Section.
 - Performing shop reviews of work instructions prior to release, incorporating sequencing improvements, and reconfiguring MAF Cells/Areas to accommodate improved workflow; we continue to evolve the factory.

ORION SPACECRAFT

Recent Progress

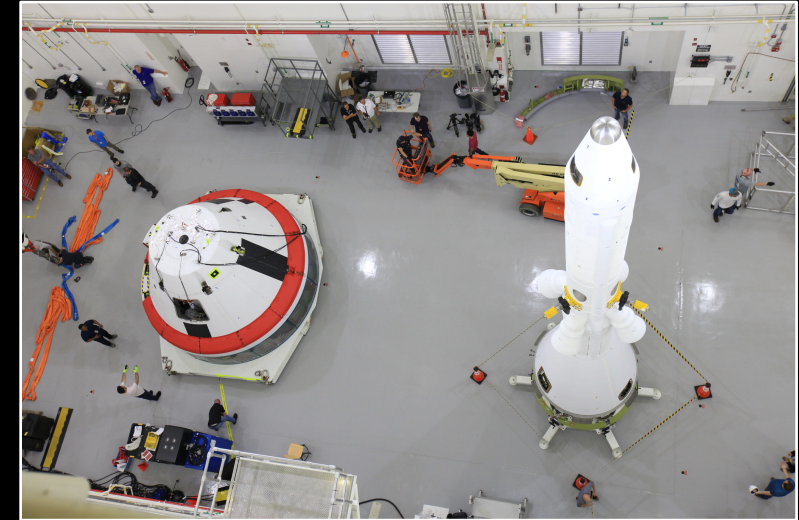
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Attitude Control Motor Test Firing



Test of Orion's crew module uprighting system off the coast of North Carolina



Launch Abort System for Ascent Abort Flight Test is vertical and integrated with the crew module test article

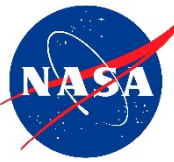


NASA Guppy aircraft modified to fit the Orion crew module and service module stack



Preparations for mating inside the Operations and Checkout High Bay

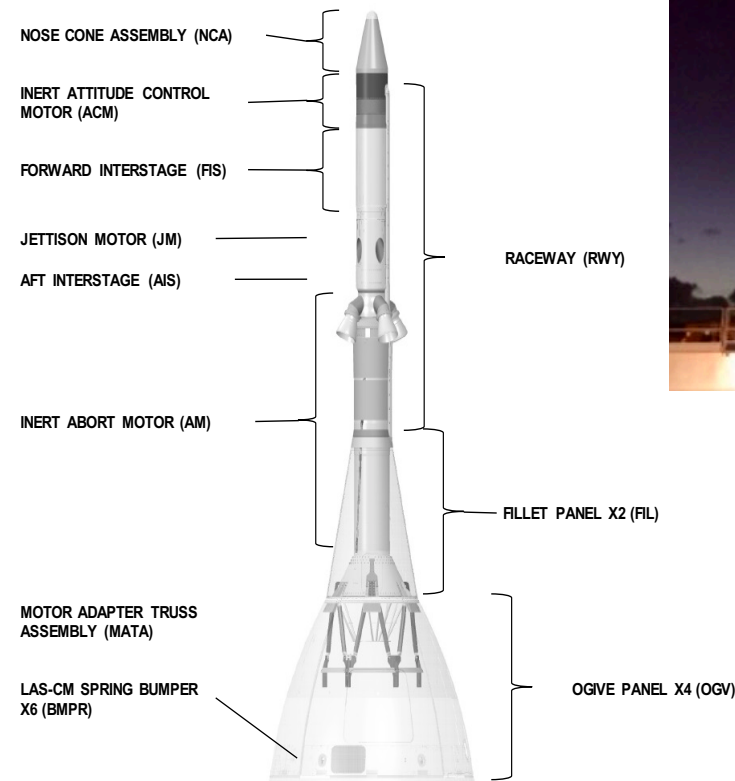
Artemis 1 and Ascent Abort (AA)-2 Launch Abort System (LAS) (Lockheed)



Exploration Systems Development Update – May 28, 2019

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- ✓ AA-2 LAS Abort Motor On Dock (O/D) KSC - August 2018
- ✓ AA-2 LAS Jettison Motor (JM) O/D KSC - September 2018
- ✓ AA-2 LAS Attitude Control Motor O/D KSC – December 2018
- ✓ AA-2 Fairing Components thru February 2019
- ✓ Artemis 1 LAS Jettison Motor delivery available – March 2019
- ✓ LAS/Crew Module Separation Ring (CSR) Mate – March 2019
- AA-2 Launch – July 2019
- Artemis 1 LAS Tower Integration – August 2019
- Artemis 1 LAS Closeout, Processing, and Staging – September 2019
- Artemis 1 LAS Complete September 2019



LAS at KSC for the AA-2 flight test



AA-2 Motors O/D KSC



Artemis 1 Jettison Motor Available



AA-2 Motors O/D KSC



AA-2 Launch



LAS Tower Integration



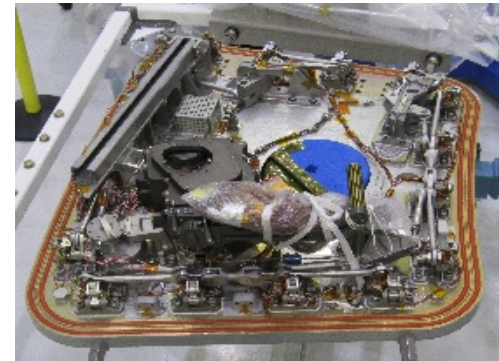
LAS Complete

Artemis 1 Crew Module (CM) (Kennedy Space Center Operations & Checkout (O&C) Building)

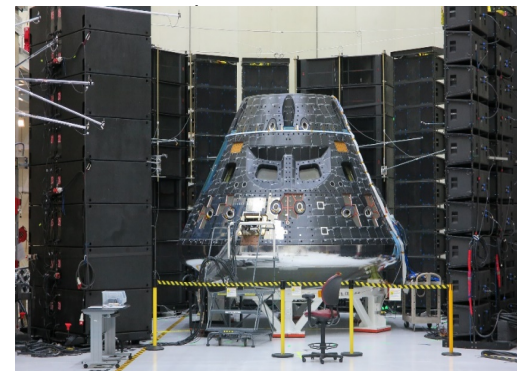
Exploration Systems Development Update – May 28, 2019

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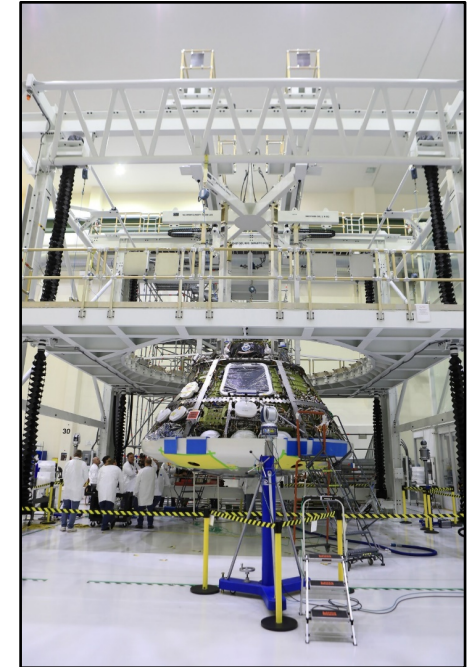
- ✓ Heatshield Installation – August 2018
- ✓ Reinstall reworked avionics (hybrid issue) – (troubleshooting last component) – January 2019
- ✓ CM Initial Power Up Test – February 2019
- ✓ Side Hatch installation & leak tests – April 2019
- ✓ CM Direct Field Acoustics Test (DFAT) – May 2019
- CM Complete - June 2019
- CM/Service Module (SM) Mate –June 2019



Artemis 1 Side



CM DFAT



Artemis 1 Heat Shield Installation at KSC

✓ CM module level test

✓ CM thermal cycle testing

✓ Heatshield and Backshell fit

✓ Heatshield installation

✓ Leak Testing

✓ CM DFAT

◻ CM/SM Mate

Artemis 1 Service Module (SM) (KSC O&C Building)

Exploration Systems Development Update – May 28, 2019

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- ✓ Crew Module Adapter (CMA) Ready to Mate – September 2018
- ✓ European Service Module (ESM) Delivered – November 2018
- ✓ CMA/ESM mate to form Service Module (SM)- November 2018
- ✓ SM Clean Room Ops – Prop/Environmental Control and Life Support systems (ECLSS) Welding – December 2018
- ✓ SM proof/leak test – January 2019
- ✓ SM initial power up and functional tests – February – April 2019
- ✓ SM thermal test cycle – April 2019
- ✓ Nozzle/Spacecraft Adapter Installation – April 2019
- ✓ SM Direct Field Acoustics Test (DFAT) - May 2019
- SM Ready to Mate with Crew Module (CM) – June 2019



SM being prepared for DFAT at KSC



CMA/ESM
Mate



CMA/ESM
proof/leak test



SM initial power
up/ functional
tests



SM thermal
cycle test



SM DFAT



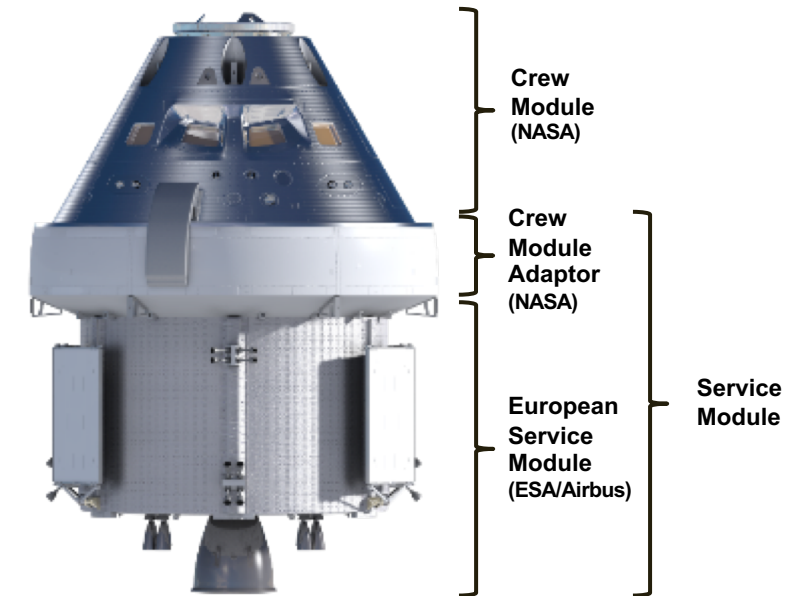
CM/SM Mate

Artemis 1 Crew and Service Module (CSM) (KSC O&C Building)

Exploration Systems Development Update – May 28, 2019

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- CM/SM Mate to form CSM - June 2019
- CSM FAST Cell Operations – June - July 2019
 - CSM Initial Power Up
 - CSM Subsystem Integration
 - CSM Integration Spacecraft Testing
- CSM Transport to Plum Brook – August 2019



CM/SM Mate



CSM Functional Test



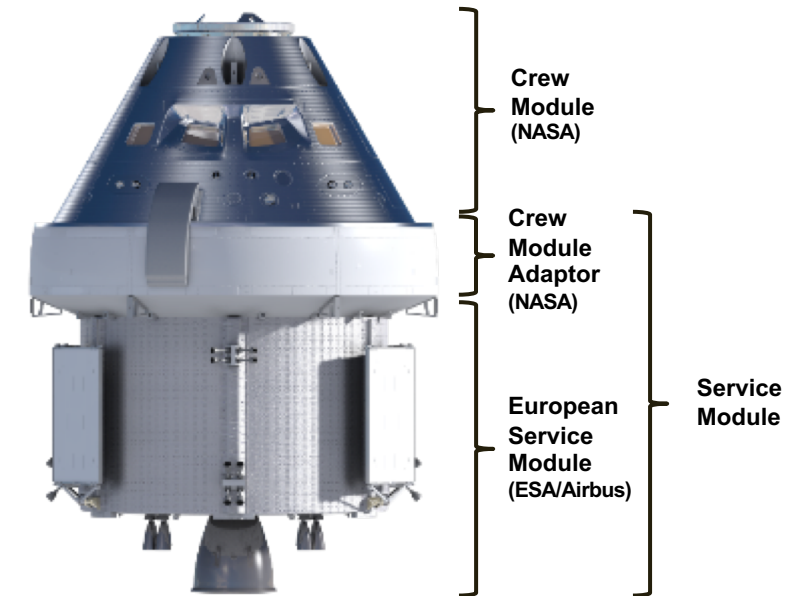
Transport to Plum Brook

Artemis 1 CSM Environmental Testing (Plum Brook Station (PBS))

Exploration Systems Development Update – May 28, 2019

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- CSM Received at PBS– August 2019
- CSM Thermal Vacuum Testing complete – October 2019
- CSM Thermal balance test complete – October 2019
- CSM EMI/EMC test complete – November 2019
- CSM Transport to KSC – November 2019



CSM Thermal Test



CSM Thermal Balance
Test



CSM
EMI/EMC Test



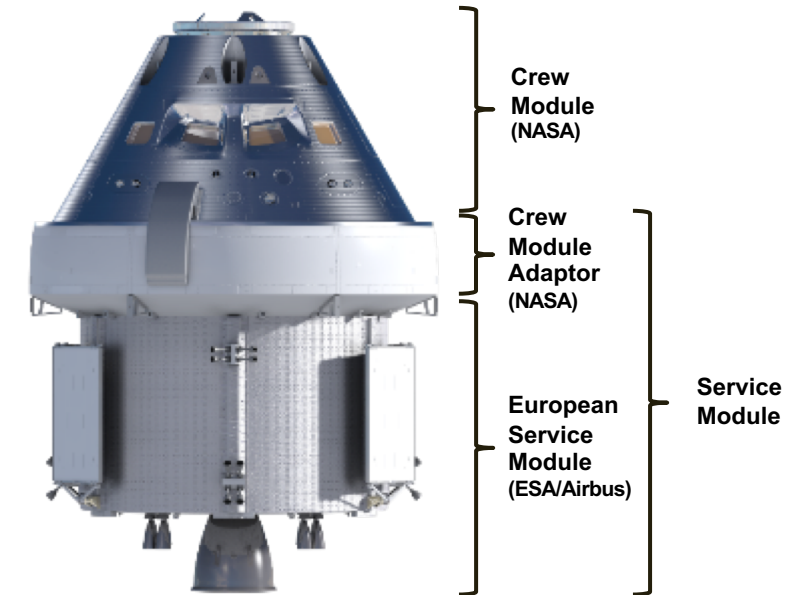
CSM to KSC

Artemis 1 CSM Final Assembly and Test (KSC O&C Building)

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- CSM Final Assembly and Test – November 2019 – January 2020
- CSM Prepare for Transfer to EGS – November 2019 – January 2020
- CSM Complete – January 2020
- CSM Turnover to EGS – February 2020



CSM Return to KSC



CSM Activity Complete



CSM Complete



Turnover to EGS

Flight Software/Integrated Test Lab (Lockheed Martin/Denver)

Exploration Systems Development Update – May 28, 2019

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Software Development

- ✓ Flight Software load 28E released 9/24/18 (GN FDIR, Partial GNC SM FDIR and Safe Mode, BFS and Redundancy Management)
- ✓ Flight Software Load 28E-Patch 1 release 10/25/18
- ✓ Flight Software Load 28E–Patch 2 release 12/17/18
- ✓ Flight Software Load 28E – Patch 3 release - 2/28/19
- ✓ Flight Software Load 28E – Patch 4 release – 4/28/19
- Flight Software Load 28E – Patch 5 release - 6/30/19
- Artemis 2 Software Release 201 – September 2019
- Artemis 2 Software Release 202 – March 2020

<input checked="" type="checkbox"/>	28E FSW Released	<input checked="" type="checkbox"/>	28E Patch 1 Release	<input checked="" type="checkbox"/>	28E Patch 2 Release	<input checked="" type="checkbox"/>	28E Patch 3 Release	<input type="checkbox"/>	28E Patch 4 Release	<input type="checkbox"/>	28E Patch 5 Release
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Integrated Test Lab (ITL)

- ATLO mission & CSM 28E testing complete – May 2019
- ITL Test Campaign verification testing complete for Artemis 1– August 2019
- ITL Convert to Artemis 2 – December 2019

<input type="checkbox"/>	28E Mission Testing	<input type="checkbox"/>	CSM testing Complete	<input type="checkbox"/>	ITL Test Campaign Verif complete – Artemis 1	<input type="checkbox"/>	ITL Convert to Artemis 2
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Build up of Artemis 2 Crew Module (CM) (Kennedy Space Center Operations & Checkout (O&C) Building)



Exploration Systems Development Update – May 28, 2019

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- ✓ CM Pressure Vessels Arrives at O&C – August 2018
- ✓ CM Primary Structure – Bird Cage Complete – January 2019
- ✓ CM Proof Pressure Test – February 2019
- ECLSS Wall Drilling, Secondary Structure, ECLSS, Prop, & Component Installation – July 2019
- Heatshield/Lower Backshell Prefit – July 2019
- Clean Room Ops – Prop/ECLSS Welding – December 2019
- CM ECLSS/Prop Proof Pressure Leak Test – January 2020
- Artemis 2 Core Avionics Delivered – July 2020
- CM Subsystem Installations – February - August 2020
- Artemis 2 Reuse Avionics October 2020
- CM Functional Tests – January 2021
- Heatshield Installation- February 2021
- CM Back Shell, Forward Bay Cover and Avionics Install – March 2021
- CM ready to mate - April 2021



Artemis 2 Crew Module at the Operations and Checkout Facility



CM Pressure Vessel Delivered



CM Proof Pressure Test



ECLSS Installation



Subsystem Installation



Heatshield and outfitting



CM ready to mate

Artemis 2 Crew Module Adapter (CMA) (KSC O&C Building)

Exploration Systems Development Update – May 28, 2019

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- CMA Structural Assembly – June 2019
- CMA Secondary Structure and Clean Room Ops – August 2019
- CMA Leak/Proof Tests – September 2019
- CMA Subsystem Installation – March 2020
- Complete Functional Test – April 2020
- Ready to Mate with the European Service Module - May 2020



CMA Structural
Assembly



Secondary Structure



Leak/Proof
Test



Complete
Functional Test



CMA Ready to
Mate

SPACE LAUNCH SYSTEM (SLS)

Recent Progress

16



LOX Structural Qualification Article (SQA) completed stack



Engine Section Integration



Final Artemis 1 Motor Segment Headed to Storage



Offloading Pathfinder from the Pegasus Barge at the SSC B-2 Test Stand



RS-25 Flight Engine Test – 16 RS-25 Engines (for the first 4 SLS flights) Now Tested

Artemis 1 ICPS/OSA/LVSA (Marshall Space Flight Center/ULA-Decatur)

Exploration Systems Development Update – May 28, 2019

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- ✓ Interim Cryogenic Propulsion Stage (ICPS) ship to United Launch Alliance at Cape Canaveral Air Force Station for final outfitting
- ✓ ICPS Delivery to KSC - July 2017 (store in Space Station Processing Facility (SSPF))
- ✓ ICPS Hardware Acceptance Review - October 2017
- ✓ Orion Stage Adapter (OSA) Production Complete - January 2018
- ✓ OSA Delivery to KSC – April 2018 (store in SSPF)
- ✓ Launch Vehicle Stage Adapter (LVSA) Thermal Protection System (TPS) application complete - April 2018
- ✓ Secondary Payload Deployment Electrical Ground Support Equipment (EGSE) delivery to KSC – September 2018
- ✓ LVSA Production Complete – January 2019
- ✓ LVSA Delivery in Place – January 2019 (coordinating Pegasus barge schedule for delivery to EGS)



Thermal Insulation Application Complete on LVSA



ICPS
Start
Production



LVSA
Start
Production



ICPS
Flight Unit
Complete



OSA
Flight Unit
Complete



LVSA
Flight Unit
Complete

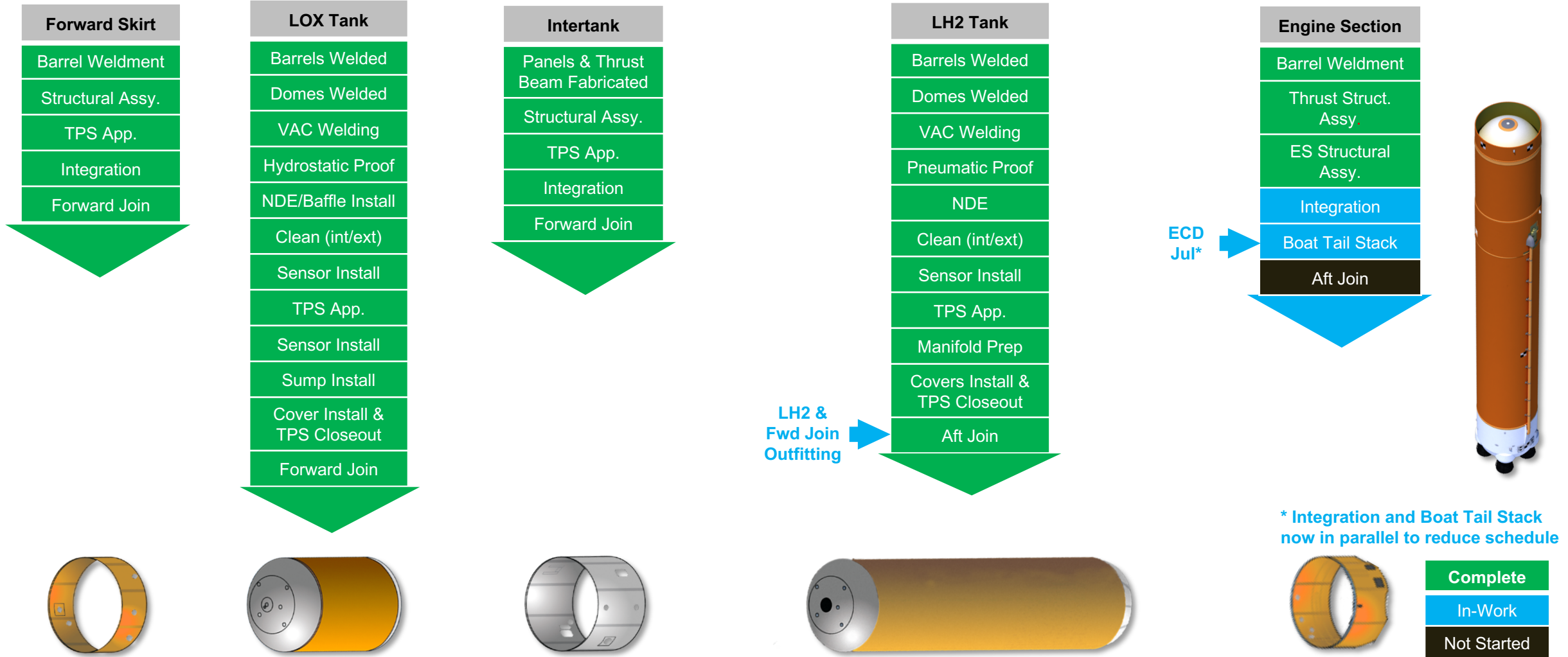


Delivery
KSC

Artemis 1 Stages (Boeing - MAF)

Exploration Systems Development Update – May 28, 2019

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Weld Confidence Articles



All CS-1 VAC Complete



FS Complete



IT Complete



LOX Tank Complete



Forward Join



LH2 Tank Complete



ES Complete



Aft Join

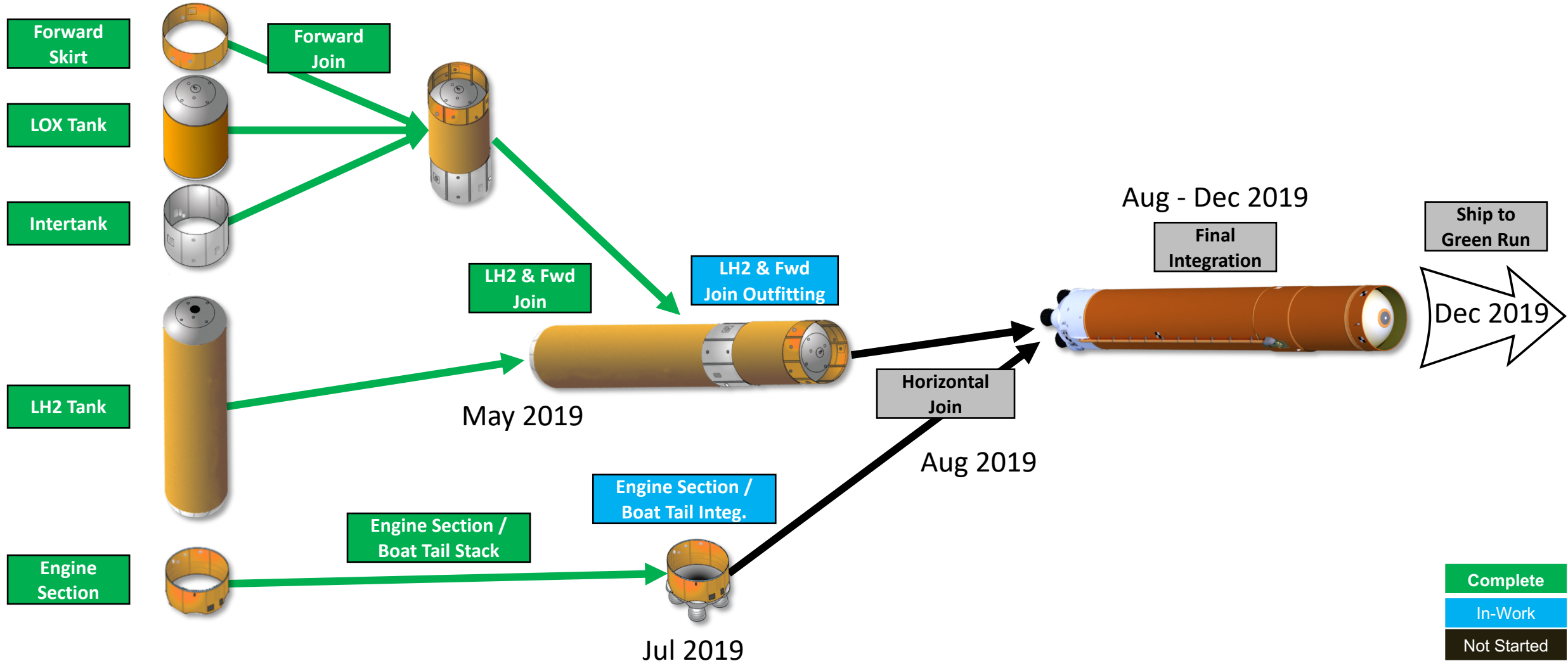


Final Join

Artemis 1 Stages (Boeing - MAF)

Exploration Systems Development Update – May 28, 2019

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Artemis 1 Boosters (Northrop Grumman - Utah)

Exploration Systems Development Update – May 28, 2019

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- ✓ All Booster Separation Motors are cast and finalized
- ✓ Artemis 1 Left & Right Hand Booster Production progressing
- ✓ All Artemis 1 Segment Casting complete (7 out of 10 Artemis 2 segments cast)
- ✓ Both Aft skirts structural refurbishment complete
- ✓ Both Artemis 1 Nozzle assemblies and Aft Exit Cones complete
- ✓ Avionics Qualification Testing Complete
- ✓ Artemis 1 Left Hand aft skirt TVC lower frame installation complete
- ✓ All 10 Artemis 1 Segments Finalized and in Storage
- ✓ Propellant-liner-insulation (PLI) flight rationale complete - November 2018
- ✓ Artemis 1 PLI Waiver signed – May 2019
- Artemis 1 Segments Ready to Ship – Plan to ship September 2019



Final Artemis 1 segment to storage



Engineers remove the core after casting the booster case with propellant

✓ Qualification
Motor (QM)-1
Test

✓ QM-2
Test

✓ Artemis 1
First Segment
Cast

✓ Artemis 1 All
Segments
Cast

☐ Artemis 1
Segments
Delivered

Artemis 1 Engines (Aerojet Rocketdyne – Stennis Space Center)

Exploration Systems Development Update – May 28, 2019

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- ✓ Held RS-25 Production Re-start Integrated Baseline Review (IBR) - May 2016
- ✓ Engine 0528 RS-25 (LOX Pump Pressure) Complete - February 2017
- ✓ Engine Control Unit (ECU) Flight Model (FM) -1 to 3 ATP Complete - April 2017
- ✓ Engine 0528 ECU Green Run Testing Complete
- ✓ Artemis 1 RS-25 Engines Delivered in Place - October 2017
 - *The Artemis 1 Flight Engines are Engine 2045, Engine 2056, Engine 2058, and Engine 2060*
- ✓ RS-25 Development Test Campaign (First HIP bonded Main Combustion Chamber and Controller Green Runs) - August 2018 through April 2019
- ✓ Artemis 2 (Artemis 1 contingency engines) Engine Complete
 - E2059
 - E2047
 - E2063
 - E2062



Final Engine Adaptation / Software Cert Hot-fire Test



All 4 Artemis 1 Engines Delivered-in-place



ECU
Dev
Testing



ECU FM1 ATP
Complete



ECU Green Run
Testing Begins



Artemis 1 Green Run
Testing Complete



Artemis 1 RS-25
Engines Delivered to
MAF

Software Test Lab (Marshall Space Flight Center)

Exploration Systems Development Update – May 28, 2019

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Software

- ✓ Deliver Flight Software Release 13 - December 2016
- ✓ Complete Sprint 5 Flight Software Release 14 - March 2017
- ✓ Complete Sprint 6 (final sprint) Flight Software Release 14 - May 2017
- ✓ Complete Release 14 Green Run Application Software (GRAS) - June 2018
- ✓ Complete GRAS Regression Testing – January 2019
- Complete Release 14 Flight Control Application Software (FCAS) - July 2019

☒ FSW 11
Release
(Engineering)

☒ FSW 12
Release
(Engineering)

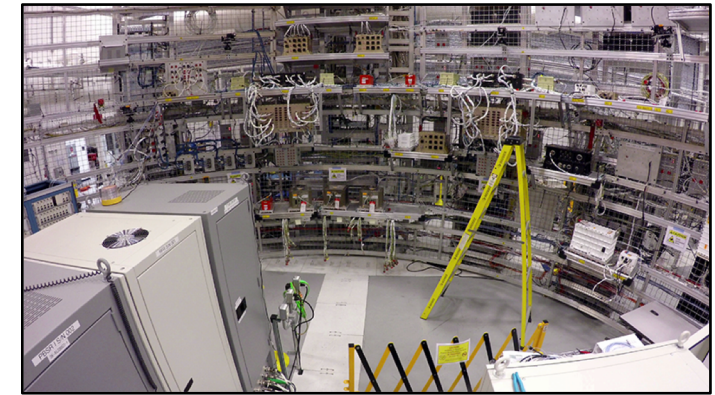
☒ FSW 13
Release

☒ FSW 14
Release
(GRAS)

☐ FSW 14
Release
(FCAS)

Software Integration Test Facility (SITF) - Qualification Testing

- ✓ Complete Phase 1 (Pwr Quality & Verif) - May 2016
- ✓ Complete Phase 2 (Command and Data Handling (C&DH) & Flight Safety System (FSS) Dry Run) - October 2016
- ✓ Complete Phase 3 (Flt Ctrl & Telemetry (TLM) Dry Run) - June 2017
- ✓ Complete Avionics Subsystem Qualification Testing - May 2019
- Complete Phase 4 (Final Avionics Verif) - November 2019



SITF Qualification Testing

☒ SITF
Development

☒ SITF
Qual Test
Ph 1 Comp

☒ SITF
Qual Test –
Ph 2 Comp

☒ SITF
Qual Test –
Ph 3 Comp

☒ SITF
Qual Test –
Av Test Comp

☐ SITF
Qual Test
Complete

Artemis 2 SLS Progress

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Artemis 2A Forward Motor Segment Thermal Protection System Installation



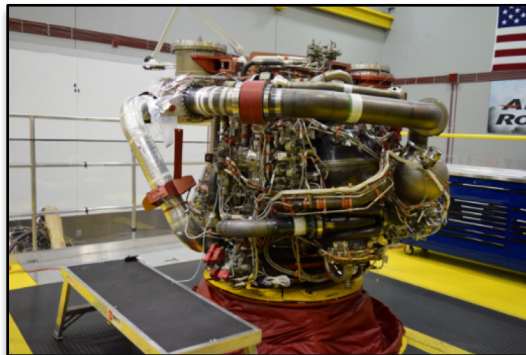
Artemis 2B Forward Motor Segment



Core stage 2 LH2 Barrel Assembly



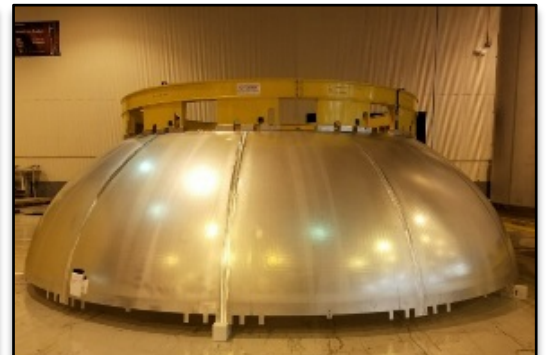
Core stage 2 Intertank Panels



Artemis 2 Flight Engines (Artemis 1 Contingency Engines)



LOX Tank Dome Assembly

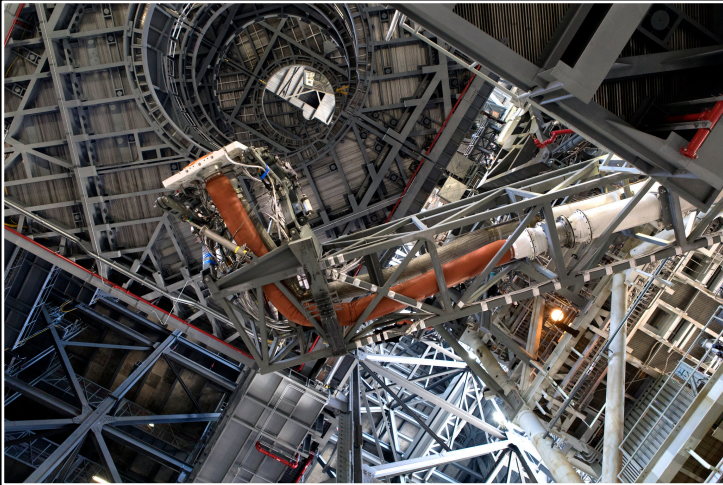


LH2 Aft Gore Assembly

EXPLORATION GROUND SYSTEMS

Recent Progress

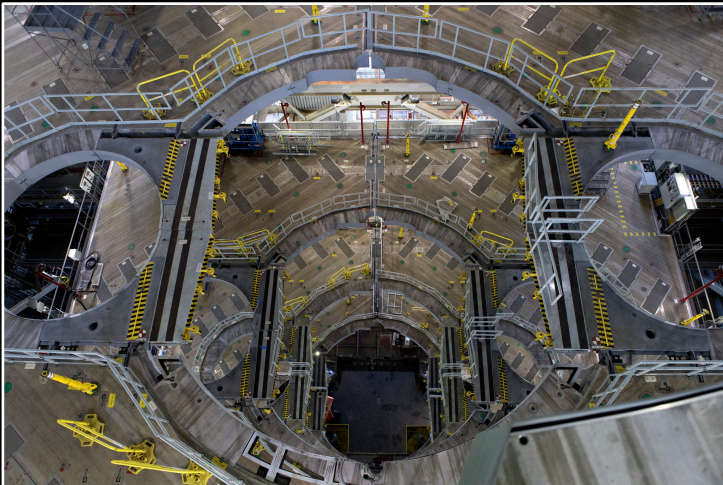
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Preliminary swing test is being performed on the Core Stage Inter-tank Umbilical



Two concrete pumper trucks pour the foundation to support the new LH2 Dewar at Pad 39B



View from above work platforms in High Bay 3 of the Vehicle Assembly Building



Completion of the LH2 Dewar concrete foundation



Countdown demonstration event of cryogenic propellant loading

Mobile Launcher (KSC)

Exploration Systems Development Update to NAC – May 28, 2019

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Artemis 1 Progress

- ✓ ML Roll to VAB – September 2018
- ✓ ML ETE (End To End) Electrical V&V Completed – May 2019
- ML Pneumatics Functional Testing Complete (LO2/LH2/GMPS) – June 2019
- ML Simultaneous Retract Complete – June 2019
- ML/VAB Multi-Element (ME) V&V Complete – June 2019
- ML Roll to Pad – June 2019
- ML ETE Fluid V&V Complete (ECS/GCS) – July 2019
- ML/Pad LO2/LH2 Systems V&V Complete – August 2019
- ML/Pad Multi-Element (ME) V&V Complete – September 2019

Future Mission Development

- ✓ Concept study to finalize equipment layout for new & areas impacted by Emergency Egress System - March 2019
- ML-1 Crew/Cargo Modification Design Start – June 2019
- ML-2 Contract Award – June 2019



ML in VAB HB3 for MEVV



Umbilical
Mechanical
Installation



ML
Simultaneous
Retract



ML Pneumatics
Functional Test



ML ETE
Fluid
V&V



ML/Pad
LH2/LO2
V&V



ML/Pad
ME V&V

Vehicle Assembly Building (KSC)

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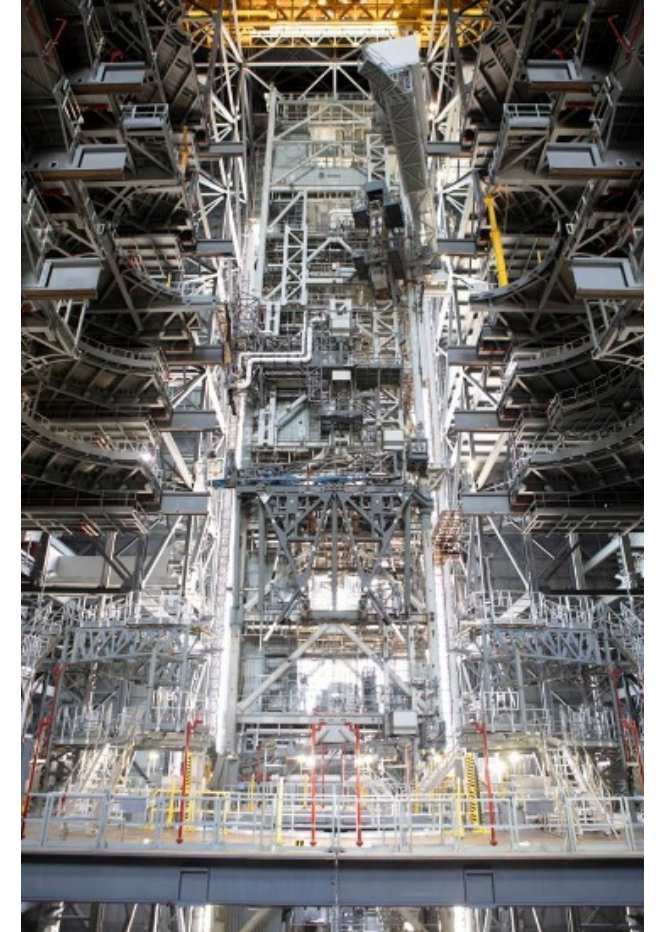
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Artemis 1 Progress

- ✓ Testing on the Environmental Control System (ECS) for Artemis 1 Completed – September 2018
- ✓ VAB Handling & Access Design Certification Review (DCR) Completed – May 2019
- VAB & Handling & Access (H&A) GSE Ready for SRB Stack – May 2019
- VAB Integrated Platform Demonstrations Complete – June 2019
- VAB Platforms Design Certification Review (DCR) – November 2019
- VAB Subsystem Transitions Complete – November 2019

Future Mission Development

- ✓ HB 3/4 90% Design Review Completed – December 2018
- ✓ VAB HB3 Platform Design Completed – March 2019
- ✓ VAB ECS Construction Started - April 2019
- VAB HB3 Platforms Construction Start – October 2019



VAB HB3 Platforms surrounding ML for MEVV



Platform
Outfitting
Complete



Fire Protection
Systems Complete



VAB/H&A GSE
Ready for SRB
Stacking



ML/VAB
ME V&V



VAB Subsystem
Transitions
Complete

Pad 39B (KSC)

Exploration Systems Development Update to NAC – May 28, 2019

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Artemis 1 Progress

- ✓ Flame Trench/Flame Deflector Completed – September 2018
- ✓ Pad ECS TRR Completed – October 2018
- ✓ Pad B ECS Testing Completed – December 2018
- ✓ Pad B Extensible Columns (XCS) Fabrication Completed – April 2019
- Pad B Ready for ML – late May 2019
- Pad B XCS Testing Complete – August 2019
- ML/Pad Multi-Element V&V Complete – September 2019
- Pad ECS Testing Complete – December 2019

Future Mission Development

- ✓ Emergency Egress System (EES) Concept study extension to evaluate ML-1 and ML-2 interchangeability Completed
- ✓ LH2 Sphere ground breaking Completed – December 2018
- ✓ Pad LN2 Skid Design Start (RL10 Chillo down) – February 2019
- ✓ Pad B EES Design Started – April 2019
- ✓ Pad B ECS Design Started – April 2019
- Converter Compressor Facility (CCF) design complete, construction start -June 2020



Pad B Extensible Columns (XCS)



Ignition
Overpressure/Sound
Suppression



LH2 Storage
Tank Fill



Flame
Trench/Deflector



Extensible
Columns
Fabrication



Pad ECS
TRR



Extensible
Columns
Testing

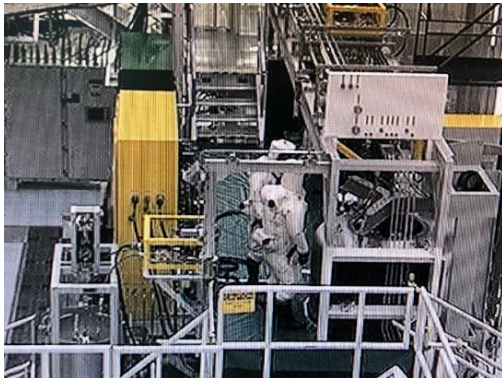
Multi-Payload Processing Facility (MPPF) (KSC)

Exploration Systems Development Update to NAC – May 28, 2019

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MPPF standalone V&V activities

- Hypergol Servicing/Deservicing V&V testing being split for Fuel and Ox Testing
 - ✓ Hyper-Fuel-Hot Flow V&V Completed – October 2018
 - Hyper - Oxidizer Hot Flow V&V Start – July 2019
- ✓ MPPF ICPS Cold Flow Demonstration Completed – April 2019
- MPPF Hyper V&V Complete – August 2019
- MPPF Subsystem Standalone/Integrated V&V Complete – August 2019
- MPPF Ready to support Vehicle Processing – September 2019



Service Module Fuel Hot Flow



Crew Module Hot Flow De-servicing



Crew/Service Module Mock-up and Orion Transporter Pallet in the Servicing Stand



V&V
Start



CMASS Haz
Testing



Orion Pallet
Handling



Hypers
V&V



MPPF V&V
Complete

Spaceport Command & Control System (SCCS)

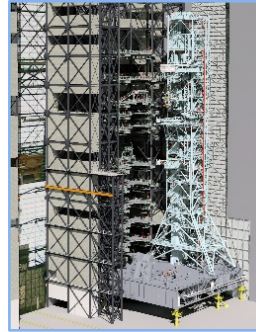
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- SCCS 5.0 – Orion Flight Vehicle Processing & GFAS V&V
- SCCS 6.0 – GFAS Regression, ITCO, WDR and Artemis 1 Launch



MPPF Hazardous Testing



MEVV @ VAB



MEVV @ Pad

- ✓ SCCS 5.0 Level 5 Online Testing – November 2018
- SCCS 5.0 Delta Sys S/W H/W Val Complete F1R (F1R Offline) – July 2019
- SCCS 6.0 Development Comp. – May 2019
- SCCS 6.0 Validation Comp. – November 2019

✓ SCCS 5.0
Engineering
Release

✓ SCCS 5.0
Validated
Release

□ SCCS 6.0
Development
Complete

□ SCCS 6.0
System Test
Complete

□ SCCS 6.0
Validated
Release

Ground Flight Application Software (GFAS)

Integrated Orion
Power-Up in
Firing Room 3



- HOTH test runs ECLSS, AVI, COM, INT GLS – May 2019
- ITL test runs ECLSS, AVI, INT GLS, FLT CNT, EPS – June 2019
- Cross Program initiatives are increasing, yielding positive results (FSW integration, OMRS scripting & pre test, LCC / GLS algorithms, Greenrun / LCD)

✓ GFAS
Drop 17

□ GFAS
Drop 22

□ GFAS
(ECLSS/Hypers)
V&V Complete

□ GFAS Ready for
ML/Pad ME V&V

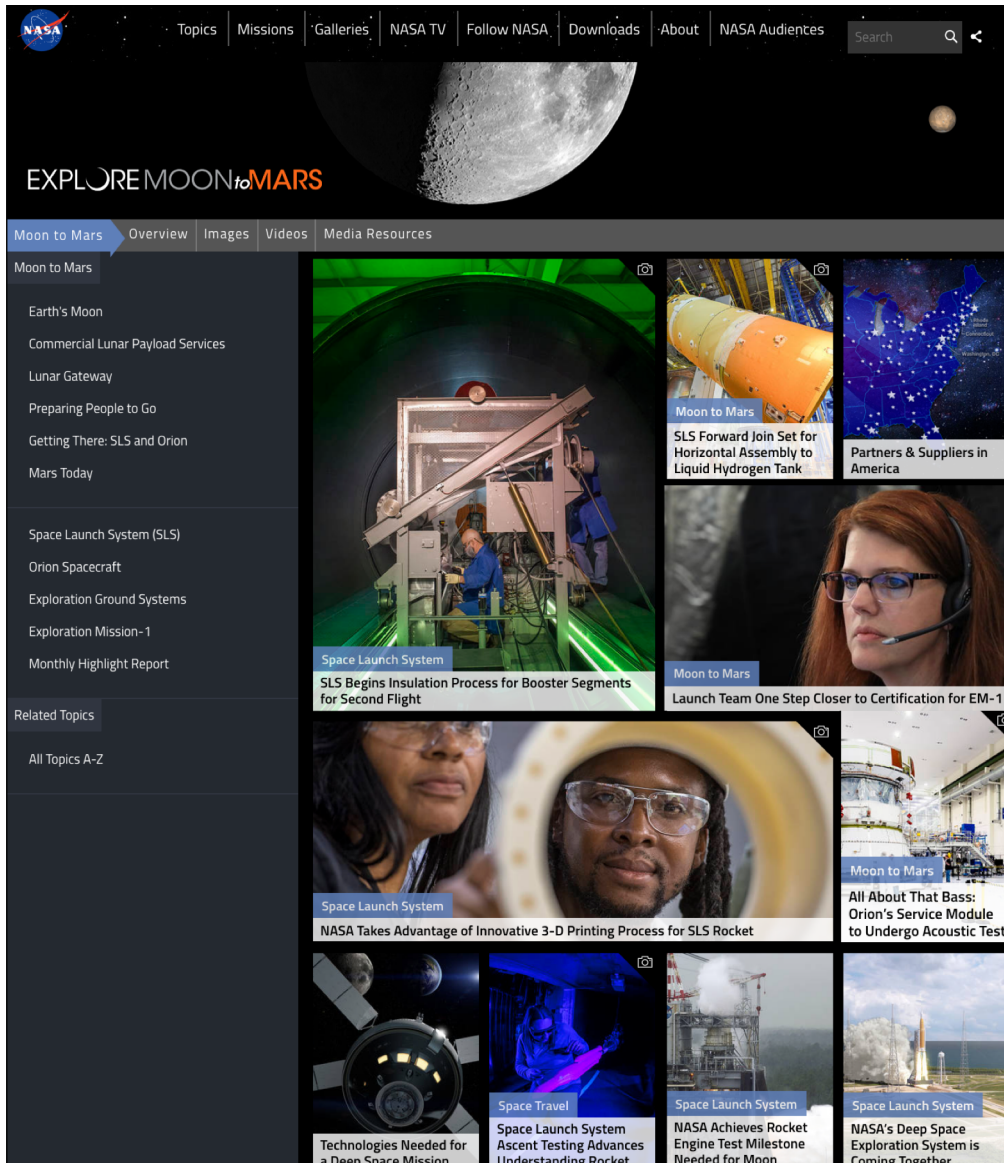
□ GFAS
SC Offline
Ready (SAR)

□ GFAS ITCO
Ready (SAR)

Exploration Systems Development – Sharing Our Story



Stay Connected Between Committee Meetings



- [SLS Begins Insulation Process for Booster Segments for Second Flight](#)
- [SLS Forward Join Set for Horizontal Assembly to Liquid Hydrogen Tank](#)
- [Launch Team One Step Closer to Certification for EM-1](#)
- [NASA Accelerates Pace of Core Stage Production with New Tool](#)
- [All About That Bass: Orion's Service Module to Undergo Acoustic Test](#)
- [NASA Takes Advantage of Innovative 3-D Printing Process for SLS Rocket](#)

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Acronyms and Abbreviations

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Acronym	Definition	Acronym	Definition	Acronym	Definition
AA	Ascent Abort	FRR	Flight Readiness Review	NDE	Nondestructive Evaluation
AI&T	Assembly, Integration, and Testing	FS	Forward Skirt	O&C	Operations and Checkout
APU	Auxiliary Power Unit	FSS	Flight Safety System	O/D	On Dock
ASEU	Aft Skirt Electrical Umbilical	FSW	Flight Software	OGV	Ogive Panel
ATLO	Assembly, Test, and Launch Operations	FWD	Forward	OMRS	Operations and Maintenance Requirements and Specifications
ATP	Authority to Proceed	GFAST	Ground/Flight Application Software Team	OMS-E	Orbital Maneuvering System Engine
BFS	Backup Flight System	GHe	Gaseous Helium	OSA	Orion Stage Adapter
C&DH	Command and Data Handling	GLS	Ground Launch Sequencer	OTP	Orion Transportation Pallet
CAA	Crew Access Arm	GN2	Gaseous Nitrogen	PCA	Pressurant Control Assembly
CM	Crew Module	GNC	Guidance, Navigation, and Control	PCDU	Power Control Distribution Unit
CMA	Crew Module Adapter	GO2	Gaseous Oxygen	PDU	Power Distribution Unit
CMASS	Crew Module Ammonia Servicing Subsystem	GR&A	Ground Rules and Assumptions	PLI	Propellant Liner Insulation
C/O	Check Out	GRAS	Green Run Application Software	PM	Program Manager
CR	Change Request	GRC	Glenn Research Center	PPE	Power and Propulsion Element
CS	Core Stage	GSE	Ground Support Equipment	PQM	Propellant Qualification Model
CSI	Cross-Program Systems Integration	H&A	Handling and Access	PRA	Probabilistic Risk Assessment
CSM	Crew and Service Module	HB	High Bay	QD	Quick Disconnect
CSS	Consumable Storage System	HOTH	Houston Orion Test Hardware	QM	Qualification Motor
CT	Crawler Transporter	ICPS	Interim Cryogenic Propulsion Stage	RCS	Reaction Control System
CUI	Controlled Unclassified Information	ICPSU	Interim Cryogenic Propulsion Stage Umbilical	SAR	System Acceptance Review
DFAT	Direct Field Acoustics Test	IPO	Initial Power On	SCCS	Spaceport Command and Control System
DVO	Detailed Verification Objectives	IT	Intertank	SCAPE	Self-Contained Atmospheric Protection Ensemble
ECD	Estimated Completion Date	ITCO	Integrated Test and Checkout	SE&I	Systems Engineering and Integration
ECLSS	Environmental Control and Life Support System	ITL	Integrated Test Laboratory	SIL	System Integration Lab
ECS	Environmental Control System	JICB	Joint Integrated Control Board	SITF	Software Integration Testing Facility
ECU	Engine Controller Unit	JM	Jettison Motor	SLS	Space Launch System
EES	Emergency Egress System	KCCS	Kennedy Complex Control System	SM	Service Module
EGS	Exploration Ground Systems	KSC	Kennedy Space Center	SSC	Stennis Space Center
EGSE	Electrical Ground Support Equipment	LAS	Launch Abort System	SSPF	Space Station Processing Facility
EMI/EMC	Electromagnetic Interference and Electromagnetic Compatibility	LCC	Launch Commit Criteria	STA	Structural Test Article
ES	Engine Section	LETF	Launch Equipment Test Facility	SW	Software
ESA	European Space Agency	LH2	Liquid Hydrogen	TCU	Thermal Control Unit
ESD	Exploration Systems Development	LN2	Liquid Nitrogen	TLM	Telemetry
ESERP	ESD Safety and Engineering Review Panel	LO2	Liquid Oxygen	TPS	Thermal Protection System
ESM	European Service Module	LOX	Liquid Oxygen	TRR	Test Readiness Review
EUS	Exploration Upper Stage	LVSA	Launch Vehicle Stage Adapter	TSMU	Tail Service Mast Umbilical
FCAS	Flight Controller Application Software	MAF	Michoud Assembly Facility	TVC	Thrust Vector Control
FCV	Flow Control Valve	MEVV	Multi-Element Verification and Validation	ULA	United Launch Alliance
FDIR	Fault Detection Isolation& Recovery	ML	Mobile Launcher	V&V	Verification and Validation
FIL	Fillet Panel	MPPF	Multi-Payload Processing Facility	VAB	Vehicle Assembly Building
FM	Flight Model	MPS	Main Propulsion System	VAC	Vertical Assembly Center
FMA	Final Mission Analysis	MSFC	Marshall Space Flight Center	WDR	Wet Dress Rehearsal
FRAC	Flight Readiness Analysis Cycle	N2	Nitrogen		