National Aeronautics and Space Administration

# J-2X Upper Stage Engine: Hardware and Testing 2009

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**AIAA Space 2009 Conference**
September 14-17, 2009

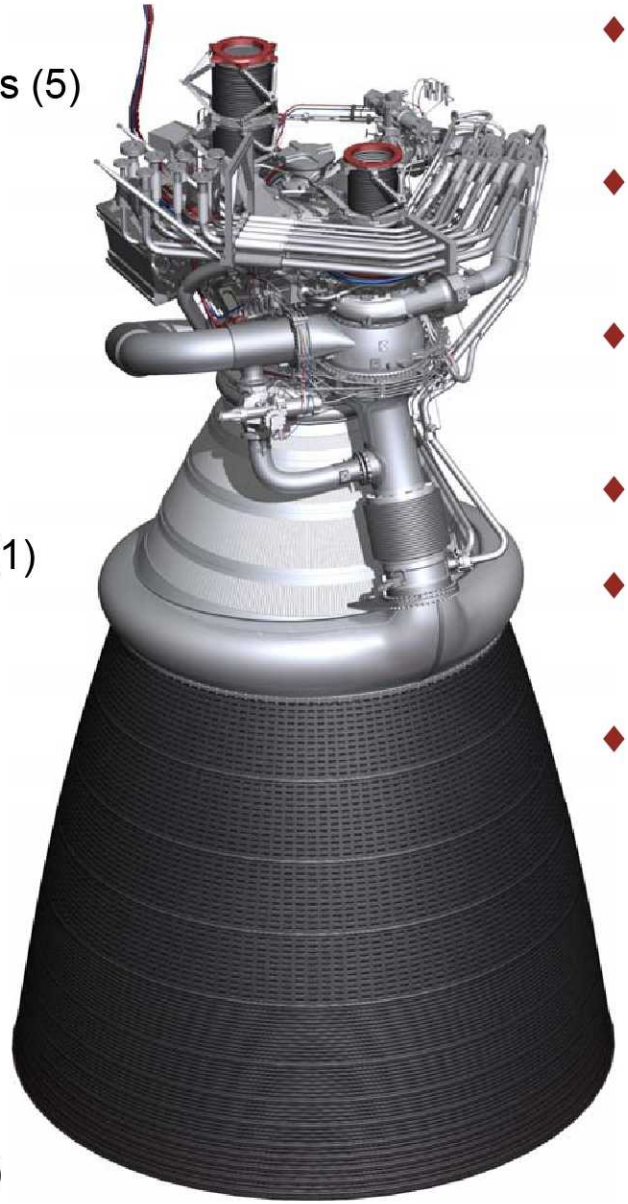
# J-2X at a Glance

- **Mission:**
  Common upper stage engine for Ares I and Ares V
- **Challenge:**
  Use proven technology from Saturn, X-33, RS-68 to develop the highest Isp GG cycle engine in history for 2 missions in record time
- **Key Features:**
  $LOX/LH_2$ GG cycle, series turbines (2), HIP-bonded MCC, pneumatic ball-sector valves, on-board engine controller, tube-wall regen nozzle/large passively-cooled nozzle extension, TEG boost/cooling
- **Development Philosophy:**
  proven hardware, aggressive schedule, early risk reduction, requirements-driven

- **USE Key Requirements**
  - Vacuum Thrust: 294,000 lbf (1307 kN)
  - Specific impulse: 448 sec (min)
  - Mixture ratio: 5.5
  - Run duration: 500 seconds
  - Weight: 5,535 (2,516 kg)
  - Size: 120” dia x 185” long
  - Life: 8 starts / 2600 sec
  - Ares V specific: on-orbit restart, 82% thrust (4.5 mixture ratio)
- **Major Hardware Ops**
  - Production – Pratt & Whitney Rocketdyne, Canoga Park, CA
  - Engine assembly – SSC, MS, Bldg 9101
  - Test – SSC, MS, Stands A1, A2, A3
  - Stage integration – MAF, LA

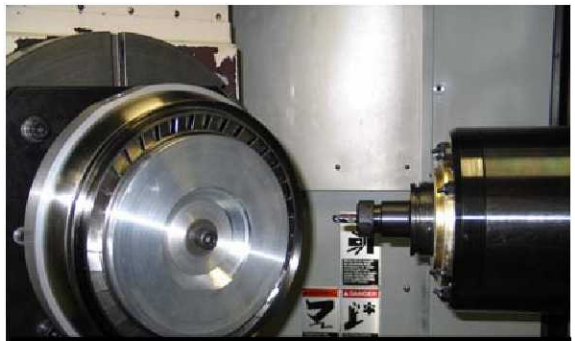
# Engine Hardware – Established at CDR 2008

- **10 DDT&E Engines**
  - Development ground test engines (5)
  - Certification ground test engines – (2)
  - Upper Stage ISTA ground test engine – (1)
  - Orion 1 flight test engine – (1)
  - Full unassembled engine (1)
- **2 Powerpack Assemblies**
  - Heritage J-2/J-2S Powerpack – (1)
  - J-2X Powerpack – (1)
- **4 Long Lead Hardware Sets**
  - Represents first 18 months of engine manufacturing
- **1 Engine Mass Simulator**
  - IVGVT, Ares I-Y
- **9 Nozzle Extensions**
  - Full Length – (7)
  - Stub Length for SSC A2/A3 – (2)



- **1 Set Spare Fuel and Oxidizer Turbopumps**
- **1 Set Hardware/software for J-2X HILL**
- **1 Control System for Ares SIL**
- **Engine Support Equipment**
- **Manufacturing Technology Demonstrators**
- **Component Test Articles**

# Development Engine Progress at Prime Contractor



PPA-2 FTP Nozzle
on the 5-axis Mill in B101

Vertical Turning and Milling Center
for Regen Nozzle, MCC, Pumps

Regen Nozzle Forward Manifold
Weld MTD in PMR for Inspection

PPA-2 and First Engine OTP First
Stage Discs Ready for Final Machining

OTP Bearing Carrier

OTP Manifold Casting

OTP Shaft and First Stage Blisk

Integrated Prototype ECU
in the Circuit Lab

# Development Engine Progress at Suppliers

FTP Bearing Support MTD (Capo)

Nozzle TEM Base Ring Forging and Main Injector LOX Dome Forging at Carlton Forgeworks (Paramount)

MCC Spun Liner at Spincraft (North Billerica)

OTP Volute Casting (Hitchcock)

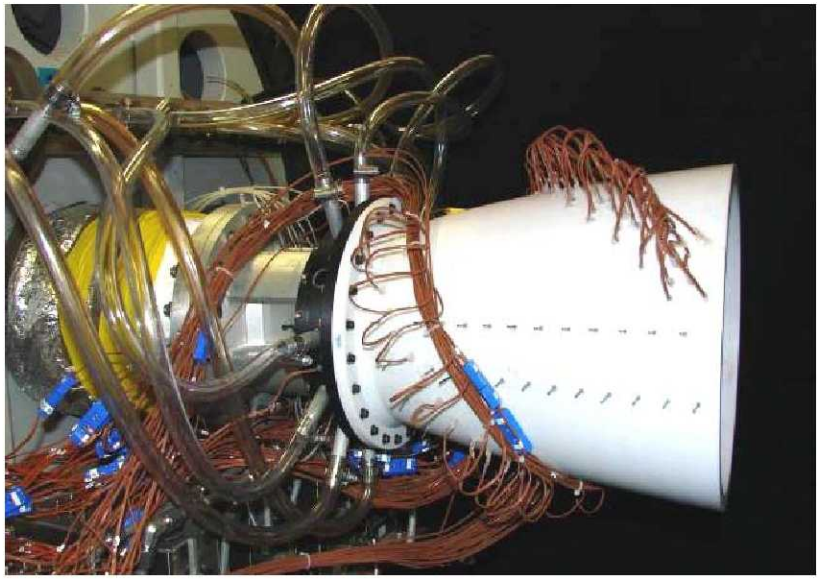
FTP Volute Casting (PCC)

Inlet Bellows MTD at Gardner Bellows (Northridge)

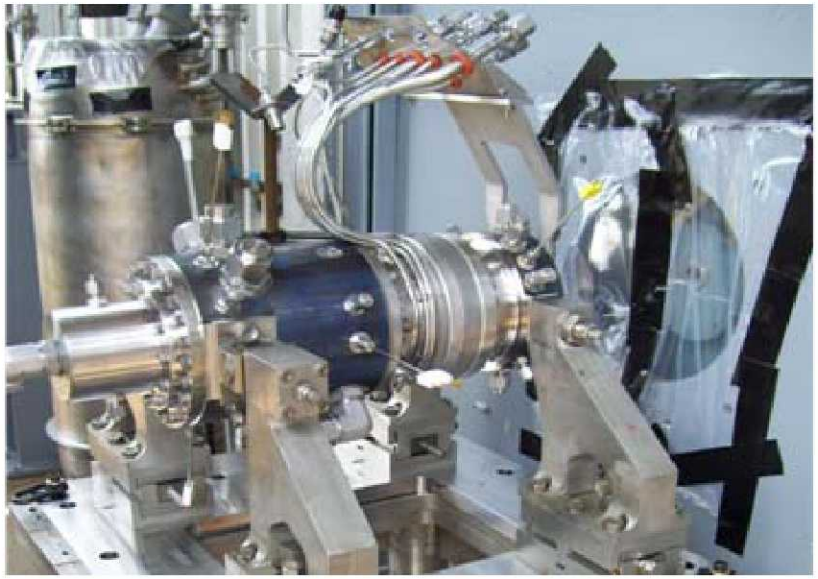
MCC Forward and Aft Manifold Castings at PPC Large Structures (Portland)

OTP Turbine Manifold Wax Mold (PAC)

# Component and GTA Progress



Supersonic Film Cooling Effectiveness



Seal Tester

Workhorse GG/turbine Simulator, Jan., April, July 2009

Hardware in the Loop Lab Expansion

# Test Facilities Progress: A3 Stand Construction


# The Future

- **Challenges:**
  - LOX and Fuel inlet duct durability
  - Gas Generator instability
  - Nozzle Extension durability
  - LOX and Fuel Turbopump structural margins
  - ECU cooling margin
  - 200 engine tests supporting Ares I-Y, ISTA, IVGVT, Orion I
- **Key Dates:**
  - SSC Stand A-2 handover – October 2009
  - PPA-2 testing – begins June 2011 (15 tests/A-1)
  - Engine 10001 hot-fire testing – begins June 2011(13 tests/A-2)
  - Engine 10001 altitude testing – begins November 2011 (10 tests/A-3)
  - Flight engine manufacturing contract starts Feb. 2010
  - DCR planned for September 2014