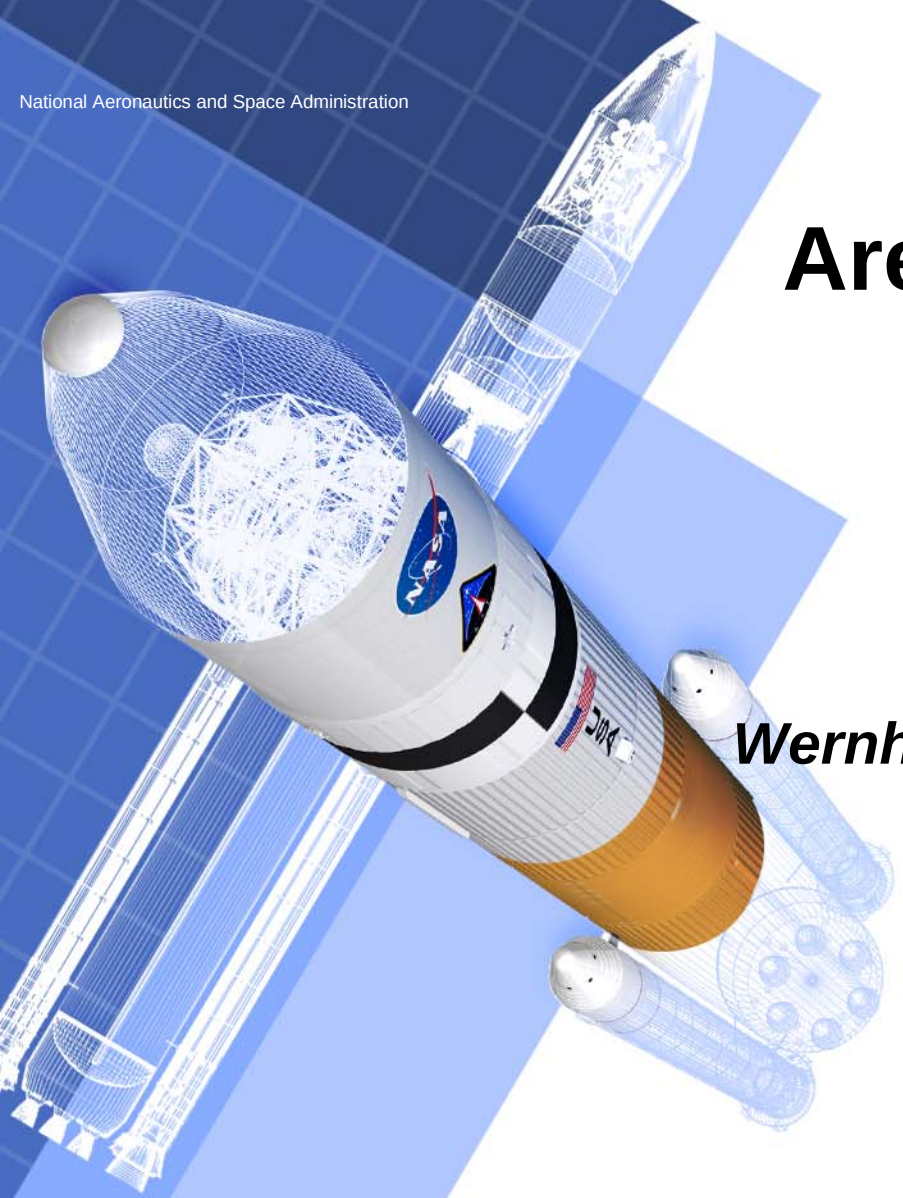
National Aeronautics and Space Administration



Ares V: Supporting Space Exploration from LEO to Beyond

American Astronautical Society
Wernher von Braun Memorial Symposium
October 21, 2008

Phil Sumrall
Advanced Planning Manager
Ares Projects Office
Marshall Space Flight Center, NASA

Agenda

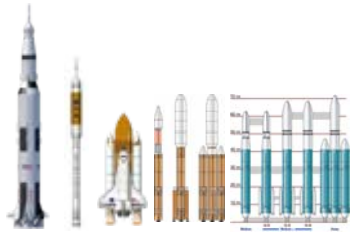
- Introduction
- Designing the Ares V
- The Ares V Timeline
- The new point-of-departure (POD) configuration
- Ares V's unprecedented capability
- Summary

Introduction

- The NASA Ares Projects Office is developing the launch vehicles to move the United States and humanity beyond low earth orbit
- Ares V is a heavy lift vehicle being designed to send crews to the Moon together with Ares I or to send cargo only in a single launch
- The Ares V design is evolving and maturing toward an authority-to-proceed milestone in 2011
- The Ares V vehicle will be considered a national asset, opening new worlds and creating unmatched opportunities for human exploration, science, national security, and space business

Ares V Design Process

Detailed Design Studies : Ares 1 Design Cycles: Other Trades and Analyses



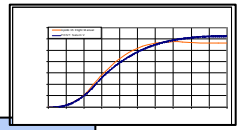
Ground Rules and Assumptions

- Historical Data
- Standard Models
- NASA Design Stds
- Industry Best Practices
- Engine Decks
- Aerodynamics Deck

Groundrules & Assumptions/ Design Reference Mission

System Weights & Sizing INTROS

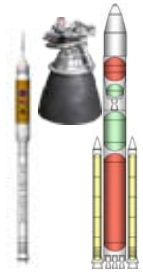
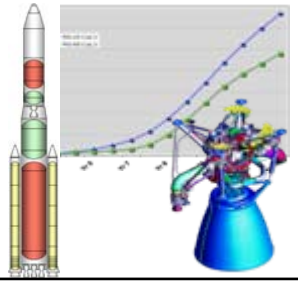
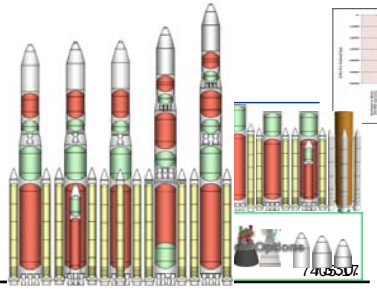
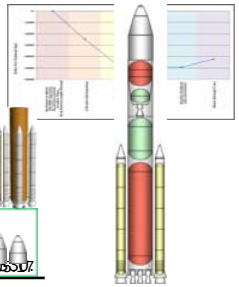
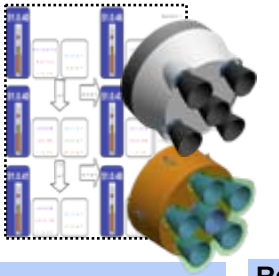
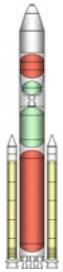
Structural Loads Analysis LVA



Trajectory POST

Ares V Concept

ESAS to LCCR Major Events

Original ESAS Capability

- *45.0 mT Lander*
- *20.0 mT CEV*
- *No Loiter in LEO*
- *8.4m OML*
- *5 SSMEs / 2J2S*

CY-06 Budget Trade to Increase

- Ares I / Ares V Commonality
- Ares I : 5 Seg RSRB / J2-X instead of Air-Start SSME
- Ares V: 1 J2-X

Detailed Cost Trade of SSME vs RS-68

- ~$4.25B Life Cycle Cost Savings for
- 5 Engine Core
- Increased Commonality with Ares I Booster
- 30-95 Day LEO Loiter Assessed

IDAC 3 Trade Space

- Lunar Architecture Team 1/2 (LAT) Studies
- Mission Delta V's increased
- Increase Margins From TLI Only to Earth through TLI
- Loiter Penalties for 30 Day Orbit Quantified

EDS Diameter Change from 8.4m to 10m

- Lunar Architecture Team 1/2 (LAT) Studies
- Lunar /Mars Systems Benefits
- Tank Assembly Tooling Commonality

Incorporate Ares I Design Lessons Learned / Parameters

- Core Engine / SRB Trades to Increase Design Margins
- Increase Subsystem Mass Growth Allowance (MGA)

Recommended Option

- *6 Core Engines*
- *5.5 Segment PBAN*

Updated Capability

- 45.0t Lander
- 20.2t CEV
- ~6t Perf. Margin
- 4 Day LEO Loiter
- Ares I Common MGAs
- HTPB Decision End of FY09

220 Concepts Evaluated

320 Concepts Evaluated

730 Concepts Evaluated

460 Concepts Evaluated

2005 | **2006** | **2007** | **2008**

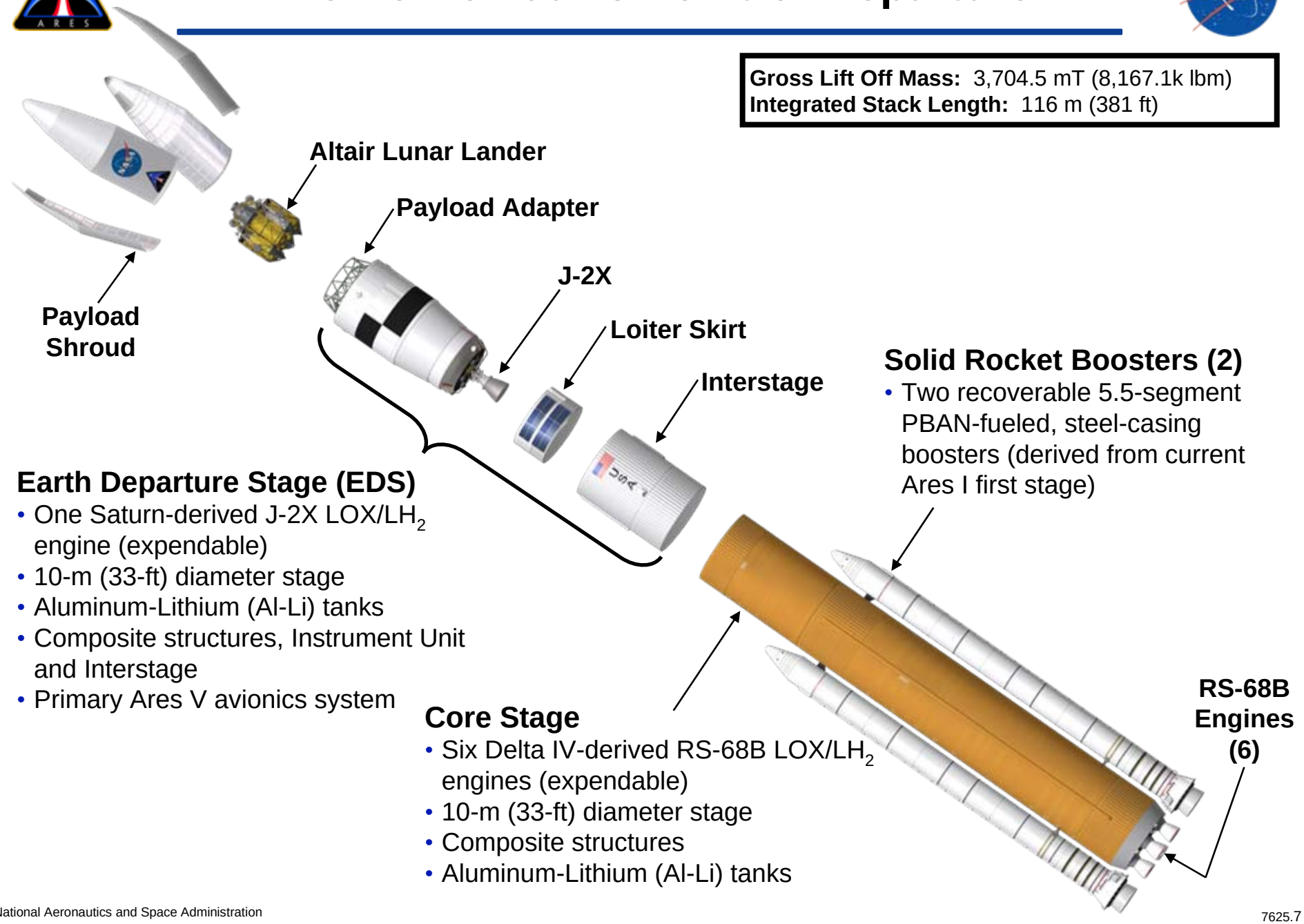
- **ESAS Complete**
- **Ares I ATP**
- **Orion ATP**
- **Ares I SRR**
- **Orion SRR**
- **Ares I SDR**
- **Ares V MCR**

Key Schedule Milestones

- MCR — Summer 2008
- ATP — Summer 2009
- PRR — Winter 2010
- SRR — Summer 2011
- SDR — Spring 2012
- PDR — Spring 2014
- CDR — Winter 2016
- First Mission Flight — Fall 2018

The New 51.00.48 Point-of-Departure

Gross Lift Off Mass: 3,704.5 mT (8,167.1k lbm)
Integrated Stack Length: 116 m (381 ft)



Earth Departure Stage (EDS)

- One Saturn-derived J-2X LOX/LH_2 engine (expendable)
- 10-m (33-ft) diameter stage
- Aluminum-Lithium (Al-Li) tanks
- Composite structures, Instrument Unit and Interstage
- Primary Ares V avionics system

Solid Rocket Boosters (2)

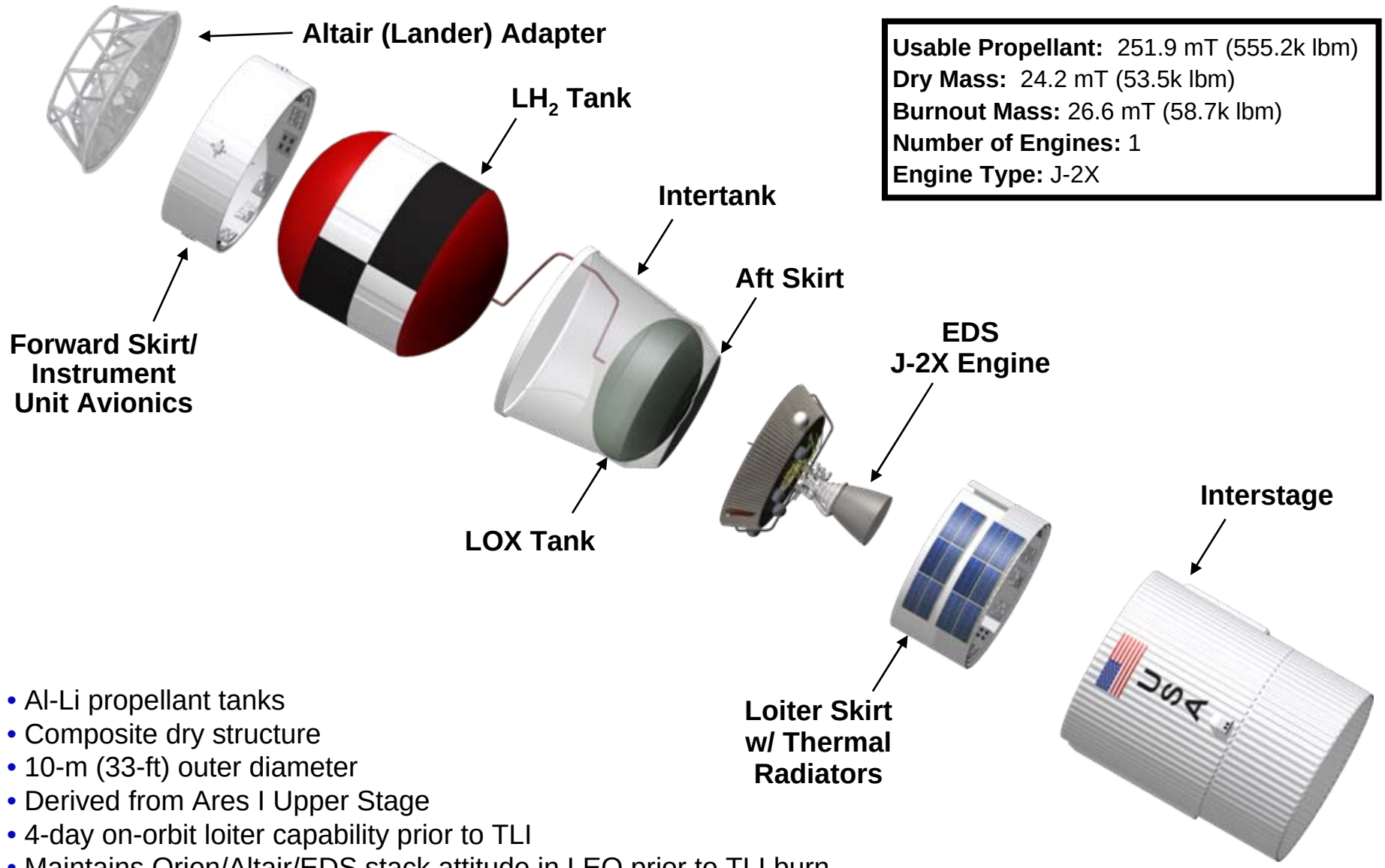
- Two recoverable 5.5-segment PBAN-fueled, steel-casing boosters (derived from current Ares I first stage)

Core Stage

- Six Delta IV-derived RS-68B LOX/LH_2 engines (expendable)
- 10-m (33-ft) diameter stage
- Composite structures
- Aluminum-Lithium (Al-Li) tanks

EDS Current Design Concept

Expanded View



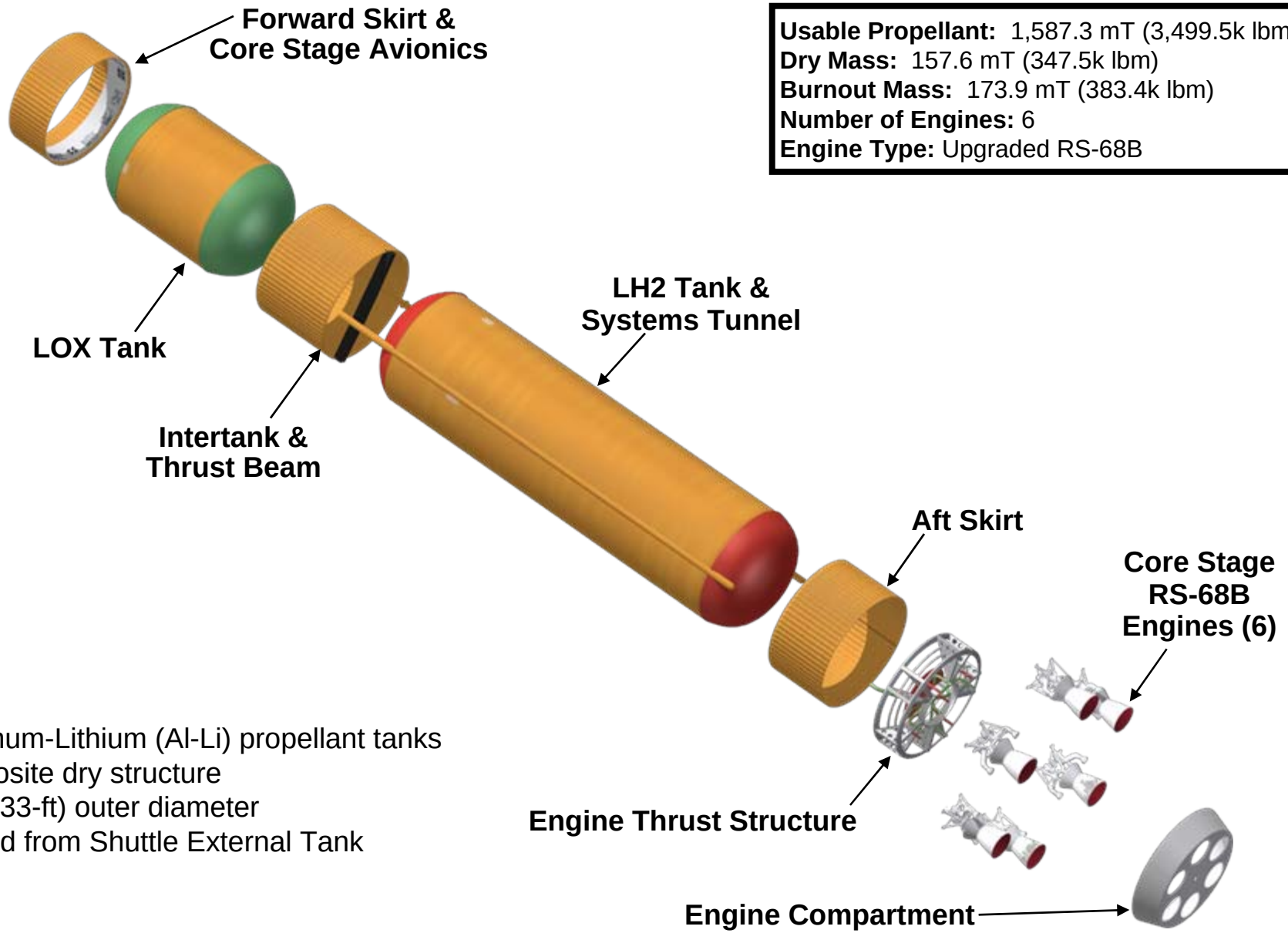
Usable Propellant: 251.9 mT (555.2k lbm)
Dry Mass: 24.2 mT (53.5k lbm)
Burnout Mass: 26.6 mT (58.7k lbm)
Number of Engines: 1
Engine Type: J-2X

- Al-Li propellant tanks
- Composite dry structure
- 10-m (33-ft) outer diameter
- Derived from Ares I Upper Stage
- 4-day on-orbit loiter capability prior to TLI
- Maintains Orion/Altair/EDS stack attitude in LEO prior to TLI burn
- EDS provides 1.5 kW of power to Altair from launch to TLI

Core Stage Design Concept

Expanded View

Usable Propellant: 1,587.3 mT (3,499.5k lbm)
Dry Mass: 157.6 mT (347.5k lbm)
Burnout Mass: 173.9 mT (383.4k lbm)
Number of Engines: 6
Engine Type: Upgraded RS-68B

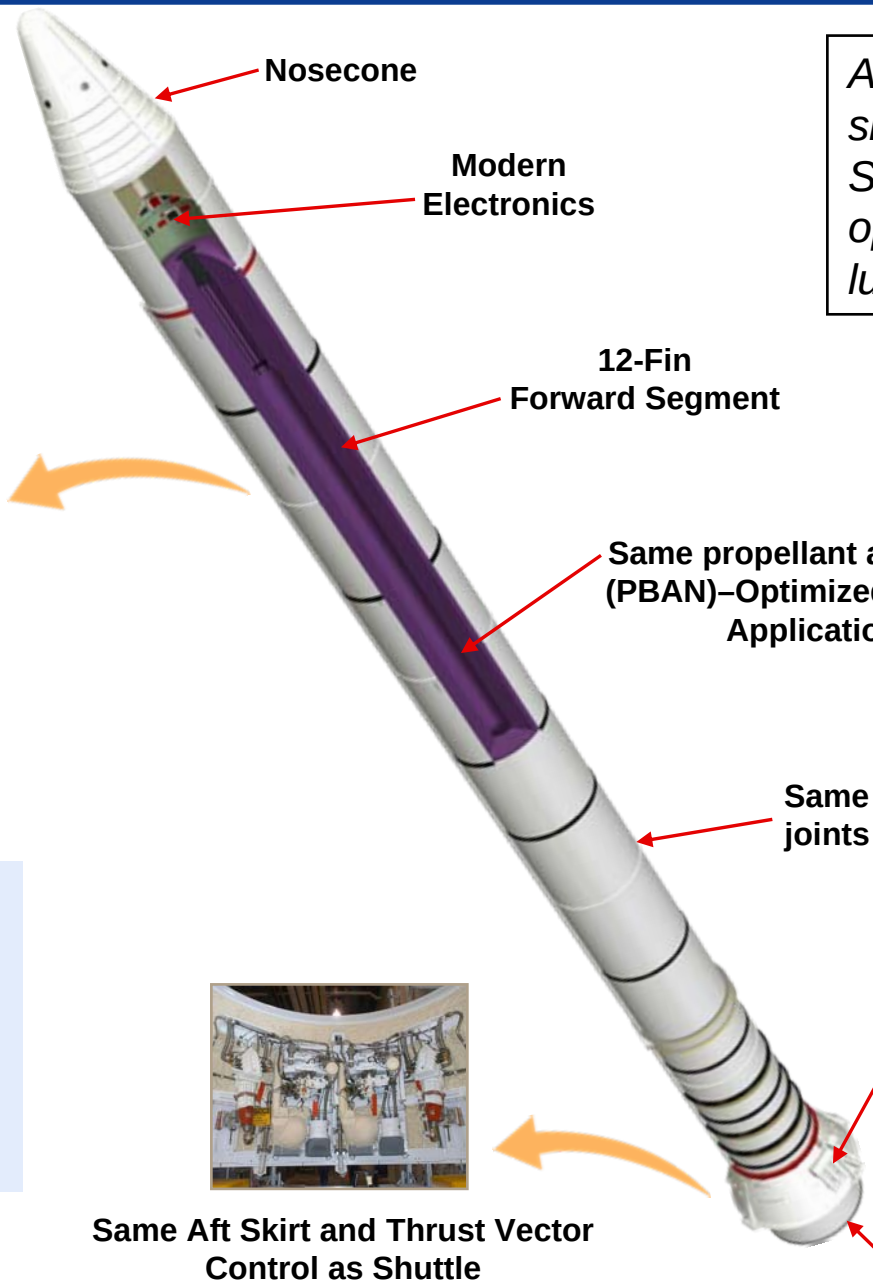


- Aluminum-Lithium (Al-Li) propellant tanks
- Composite dry structure
- 10-m (33-ft) outer diameter
- Derived from Shuttle External Tank

Ares V (51.00.48)
Solid Rocket Booster (SRB)

ATK

Ares V SRB is similar to Space Shuttle but optimized for lunar missions



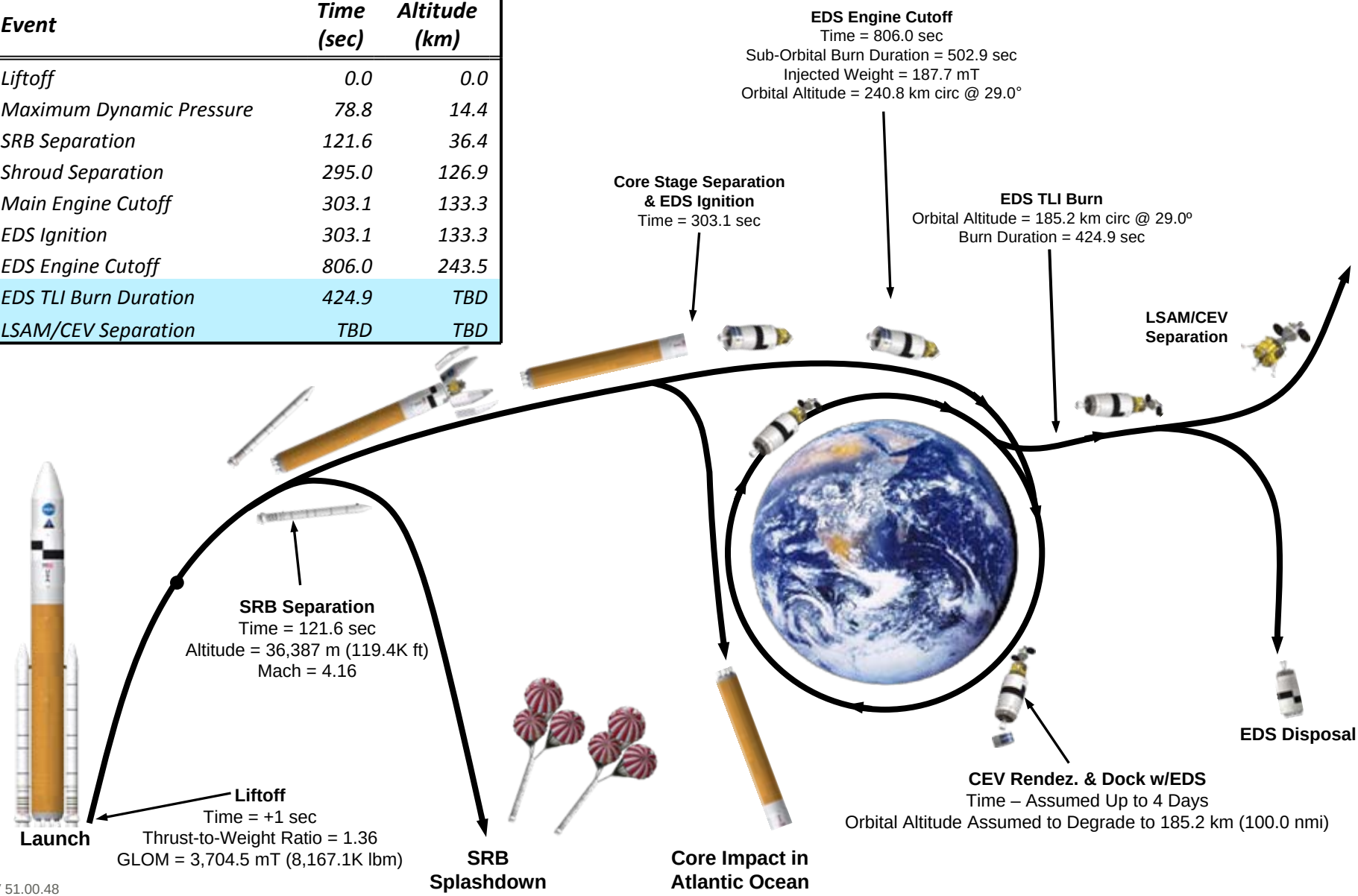
Same Aft Skirt and Thrust Vector Control as Shuttle

Mass: 794 mT (1.8M lbm)
Thrust: 15.8M N (3.79 M lbf)
Burn Duration: 126 sec
Height: 55 m (180 ft)
Diameter: 3.7 m (12 ft)

Ares V Profile for 1.5 Launch DRM

51.00.48 Point Of Departure (Lunar Sortie)

Event	*Time (sec)*	*Altitude (km)*
Liftoff	*0.0*	*0.0*
Maximum Dynamic Pressure	*78.8*	*14.4*
SRB Separation	*121.6*	*36.4*
Shroud Separation	*295.0*	*126.9*
Main Engine Cutoff	*303.1*	*133.3*
EDS Ignition	*303.1*	*133.3*
EDS Engine Cutoff	*806.0*	*243.5*
EDS TLI Burn Duration	*424.9*	*TBD*
LSAM/CEV Separation	*TBD*	*TBD*



Ares V Delivers 6 Times More Mass to Orbit

Sun

Earth

Moon

Hubble in LEO

Current Capabilities can Deliver

~ 25,000 kg to Low Earth Orbit
~10,000 kg to GTO or L2TO Orbit
5 meter Shroud

Ares V can Deliver

~185,000 kg Initial Mass to Low Earth Orbit
~60,000 kg to L2TO Orbit
10 meter Shroud

L2

1.5 M km from Earth

LEO performance for new Constellation point of departure vehicle (51.00.48) is expected to exceed values shown here. Performance analysis will be updated for the 51.00.48 vehicle.

Ares V Enabling Science Missions

- **JPL D-41883 "Ares V Application to Solar System Exploration": "In summary, there appears to be a wide range of science missions that could be launched by Ares V that would not be possible otherwise."**

- **NASA/CP-2008/214588, Workshop Report on Astronomy Enabled by Ares V: "The large fairing and lift capabilities of the Ares V opens up new design concepts, e.g. large monolithic mirrors that reduce complexity and have no risk of deployment."**

Space Telescope Mission	Current Space Telescope Designs (scaled to 8m)	Low Cost / High Margin Space Telescope
Payload	6,400kg (LW Optics eg Hubble)	23,000kg (Ground Based Optics)
Spacecraft	4,000kg	12,500kg
Fuel	600kg	2,100kg
Total	11,000kg	37,600kg

NASA Sponsored Study on Ares V Science Missions

(Aerospace Corp 2008)

Summary

- Key elements of Ares V are under development as a part of Ares I and the Air Force RS-68
- Ares V Point of Departure (POD) vehicle has ~ 40% more payload capability than Saturn V to TLI
- In conjunction with Ares I, Ares V closes the lunar architecture with 6 MT of margin to TLI
- Ares V design and development will begin in 2011
- Ares V completed its Mission Concept Review (MCR) in June of this year and is proceeding into Phase A
- Industry involvement in Ares V Phase I will support element definition to assure robust system level requirements leading to element prime contract awards in Phase II