National Aeronautics and Space Administration

Update on the Ares V to Support Heavy Lift for U.S. Space Exploration Policy

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Introduction

- The NASA Ares Projects are 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

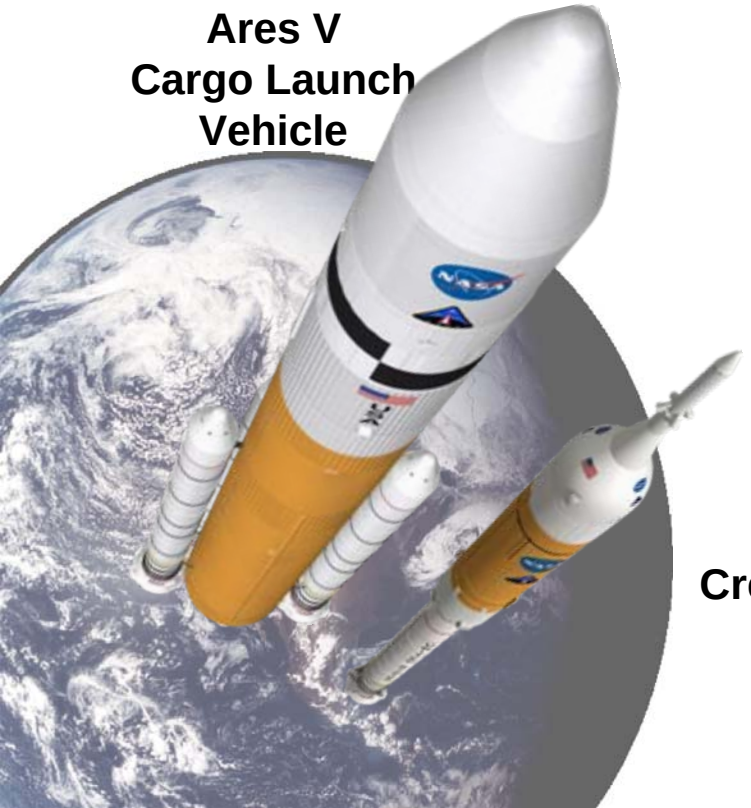
Our Exploration Fleet

What will the vehicles look like?

Earth Departure Stage

Orion
Crew Exploration
Vehicle

Ares V
Cargo Launch
Vehicle



Ares I
Crew Launch
Vehicle

Altair
Lunar
Lander

Building on a Foundation of Proven Technologies

Launch Vehicle Comparisons

Overall Vehicle Height, m (ft)

122 m (400 ft)

91 m (300 ft)

61 m (200 ft)

30 m (100 ft)

0

Orion

Upper Stage
(1 J-2X)
137.1 mT
(302.2k lbm)
LOX/LH_2

5-Segment
Reusable
Solid Rocket
Booster
(RSRB)

Altair

EDS (1 J-2X)
253.0 mT (557.7k lbm)
LOX/LH_2

Core Stage
(6 RS-68B Engines)
1,587.3 mT
(3,499.5k lbm)
LOX/LH_2

2 5.5-Segment
RSRBs

Crew

Lunar
Lander

S-IVB
(1 J-2 Engine)
108.9 mT
(240.0k lbm)
LOX/LH_2

S-II
(5 J-2 Engines)
453.6 mT
(1,000.0k lbm)
LOX/LH_2

S-IC
(5 F-1)
1,769.0 mT
(3,900.0k lbm)
LOX/RP-1

Space Shuttle

Height: 56 m (184 ft)
Gross Liftoff Mass:
2,041.1 mT (4,500.0k lbm)
Payload Capability:
25.0 mT (55.1k lbm)
to Low Earth Orbit (LEO)

Ares I

Height: 99.1 m (325 ft)
Gross Liftoff Mass:
927.1 mT (2,044.0K lbm)
Payload Capability:
25.5 mT (56.2K lbm)
to LEO

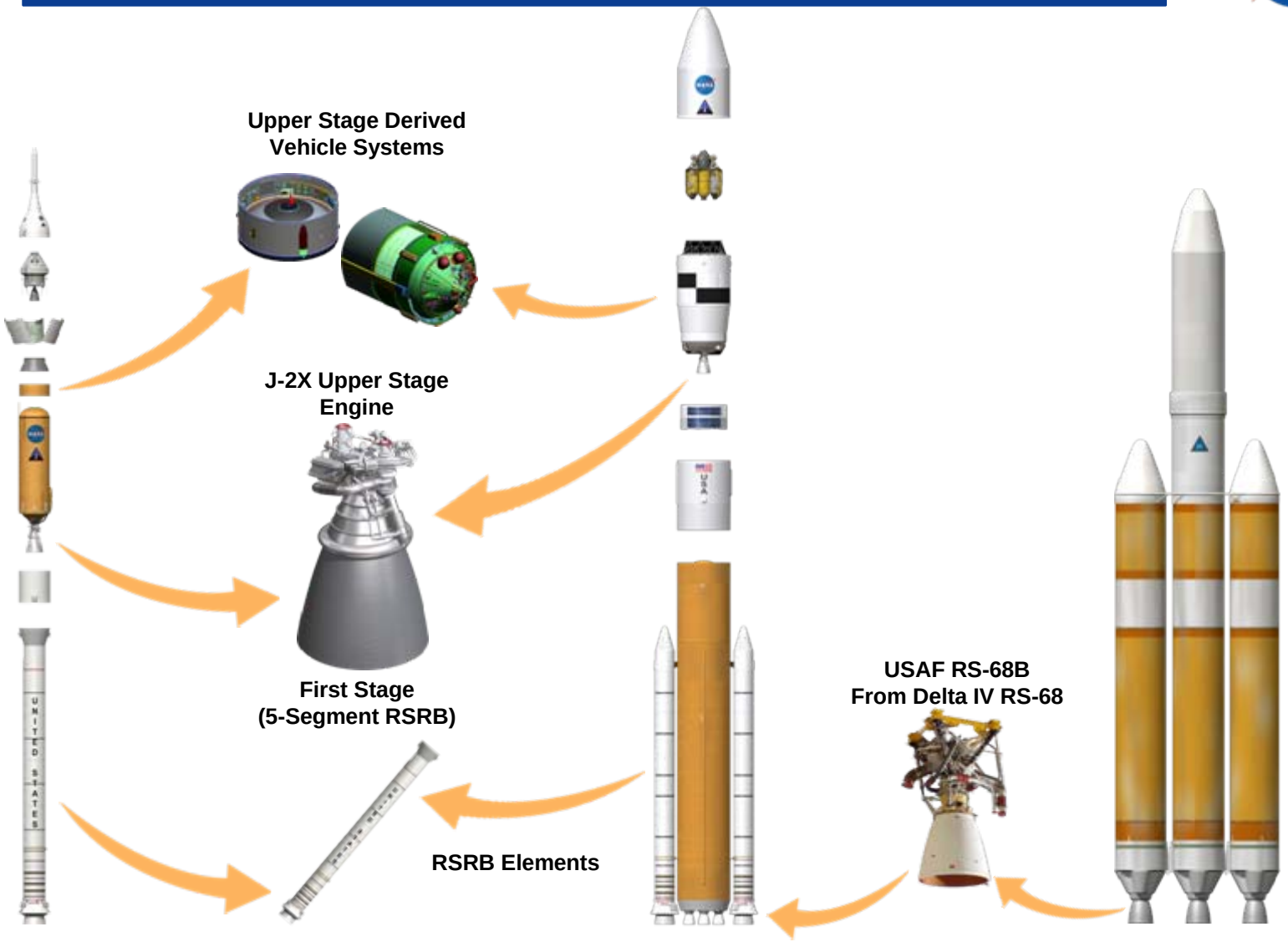
Ares V

Height: 116.2 m (381.1 ft)
Gross Liftoff Mass:
3,704.5 mT (8,167.1K lbm)
Payload Capability:
71.1 mT (156.7K lbm) to TLI (with Ares I)
62.8 mT (138.5K lbm) to Direct TLI
~187.7 mT (413.8K lbm) to LEO

Saturn V

Height: 111 m (364 ft)
Gross Liftoff Mass:
2,948.4 mT (6,500k lbm)
Payload Capability:
44.9 mT (99.0k lbm) to TLI
118.8 mT (262.0k lbm) to LEO

Ares V Element Heritage



Ares I

25.5 mT (56.2 klbm) to Low Earth Orbit (LEO)

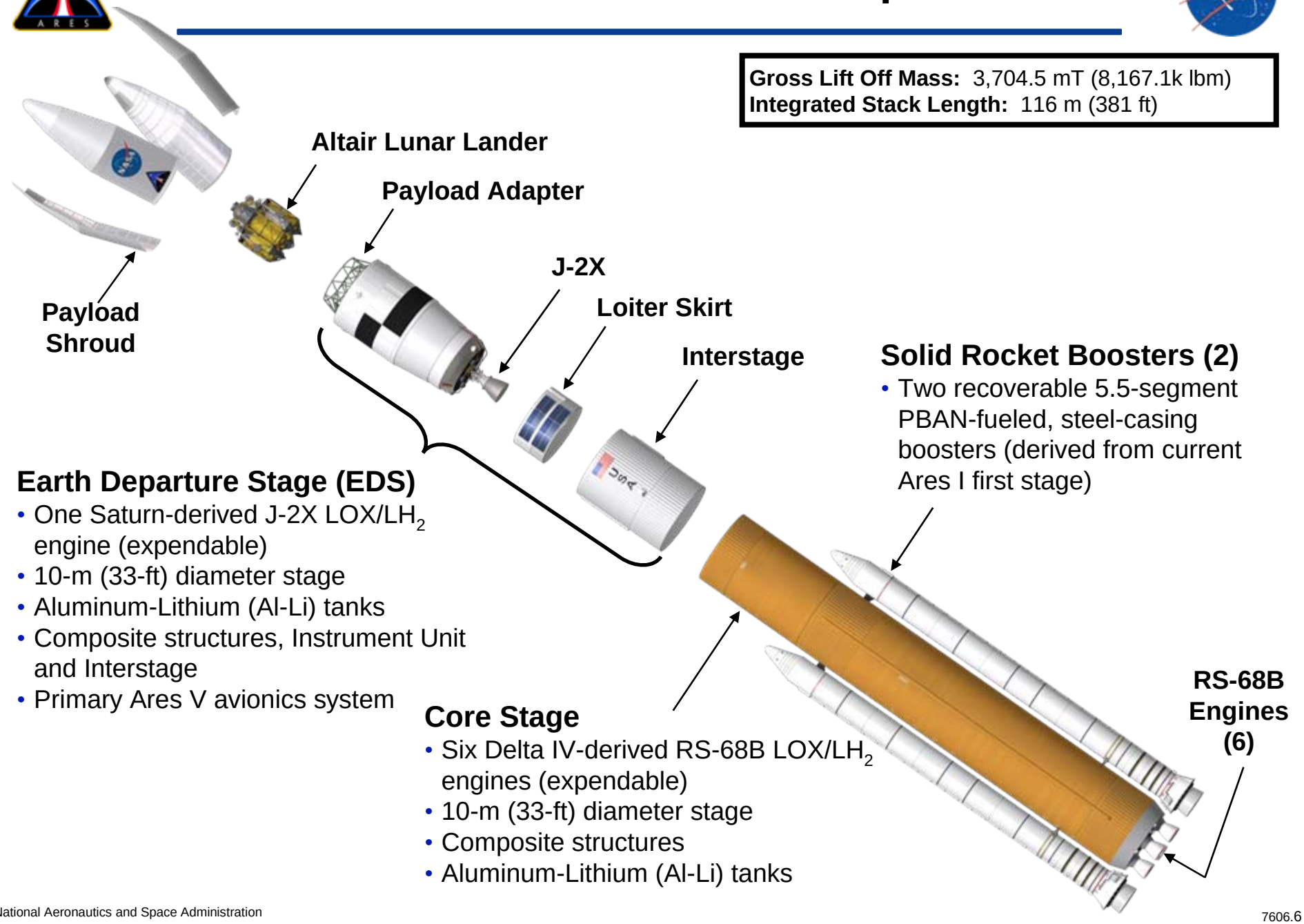
Ares V (51.00.48)

71.1 mT (156.7 klbm) to TLI (with Ares I)
63.0 mT (138.5 klbm) to Direct TLI
187.7 mT (413.8 klbm) to LEO

Delta IV

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)

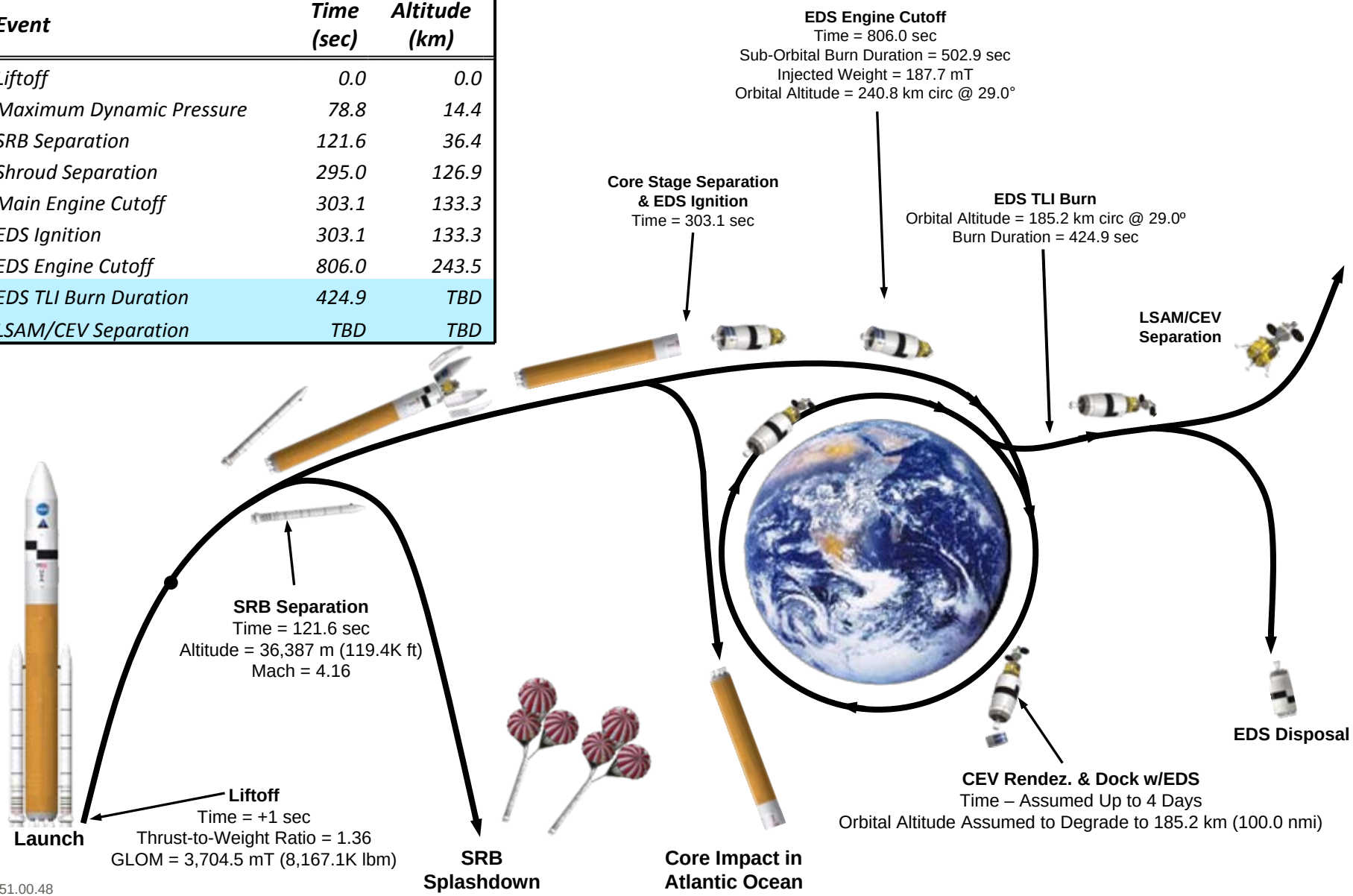
Core Stage

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

Ares V Profile for 1.5 Launch DRM

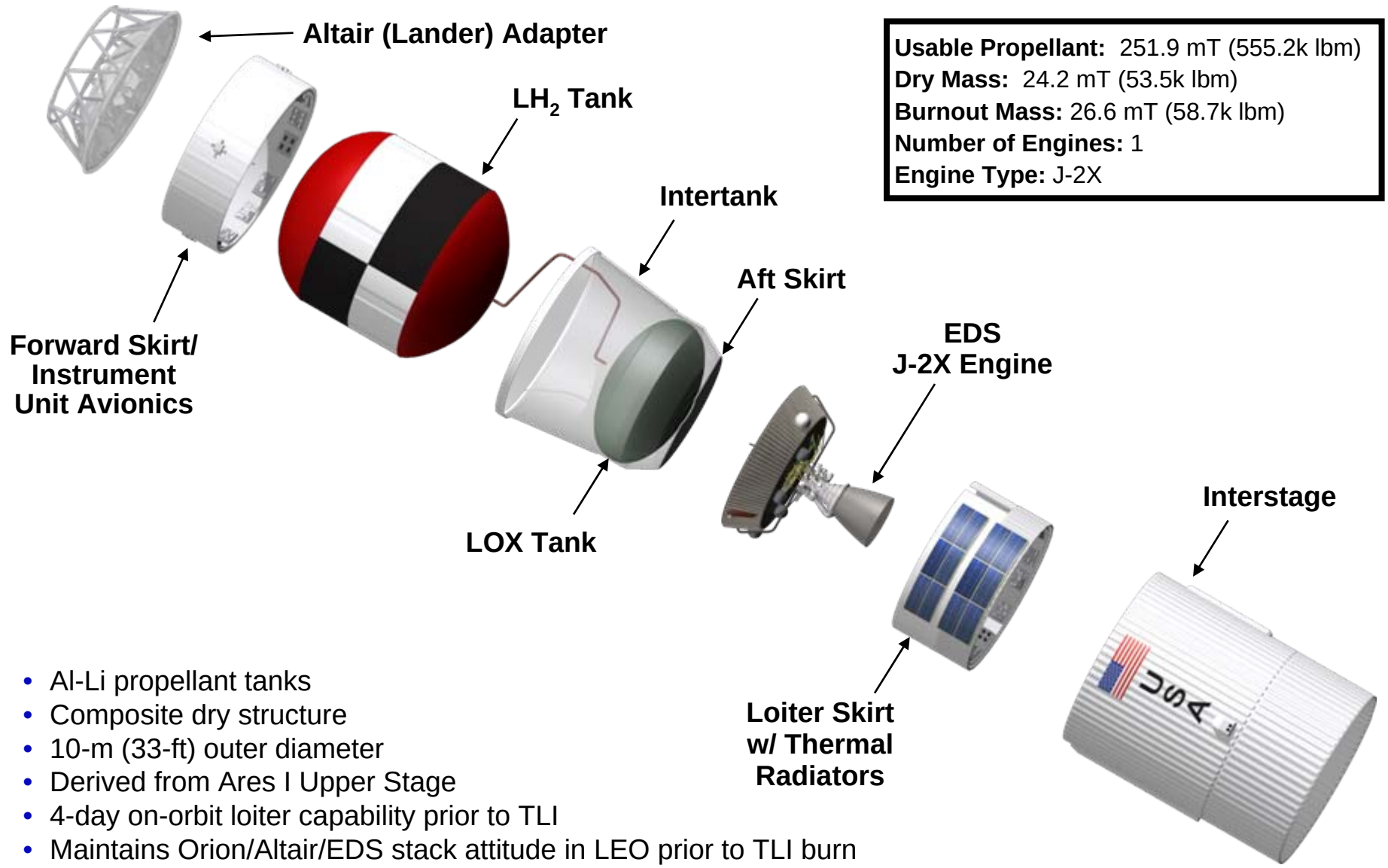
51.00.48 Point Of Departure (Lunar Sortie)

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*



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

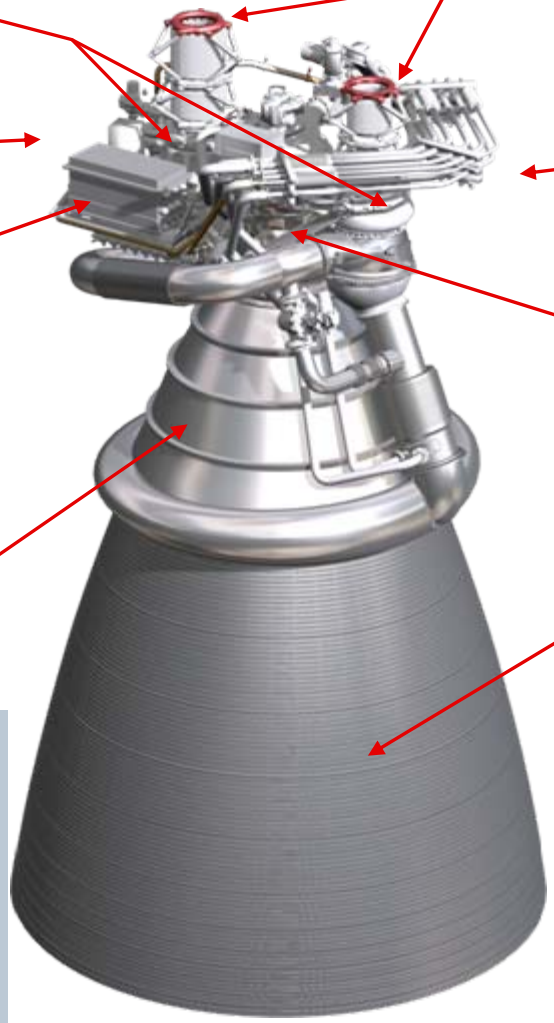
Earth Departure Stage J-2X Engine

Turbomachinery
- Based on J-2S MK-29 design

Gas Generator
- Based on RS-68 design

Engine Controller
- Based directly on RS-68 design and software architecture

Regeneratively Cooled Nozzle Section
- Based on long history of RS-27 success



Flexible Inlet Ducts
- Based on J-2 & J-2S ducts

Open-Loop Pneumatic Control
- Similar to J-2

HIP-bonded MCC
- Based on RS-68 demonstrated technology

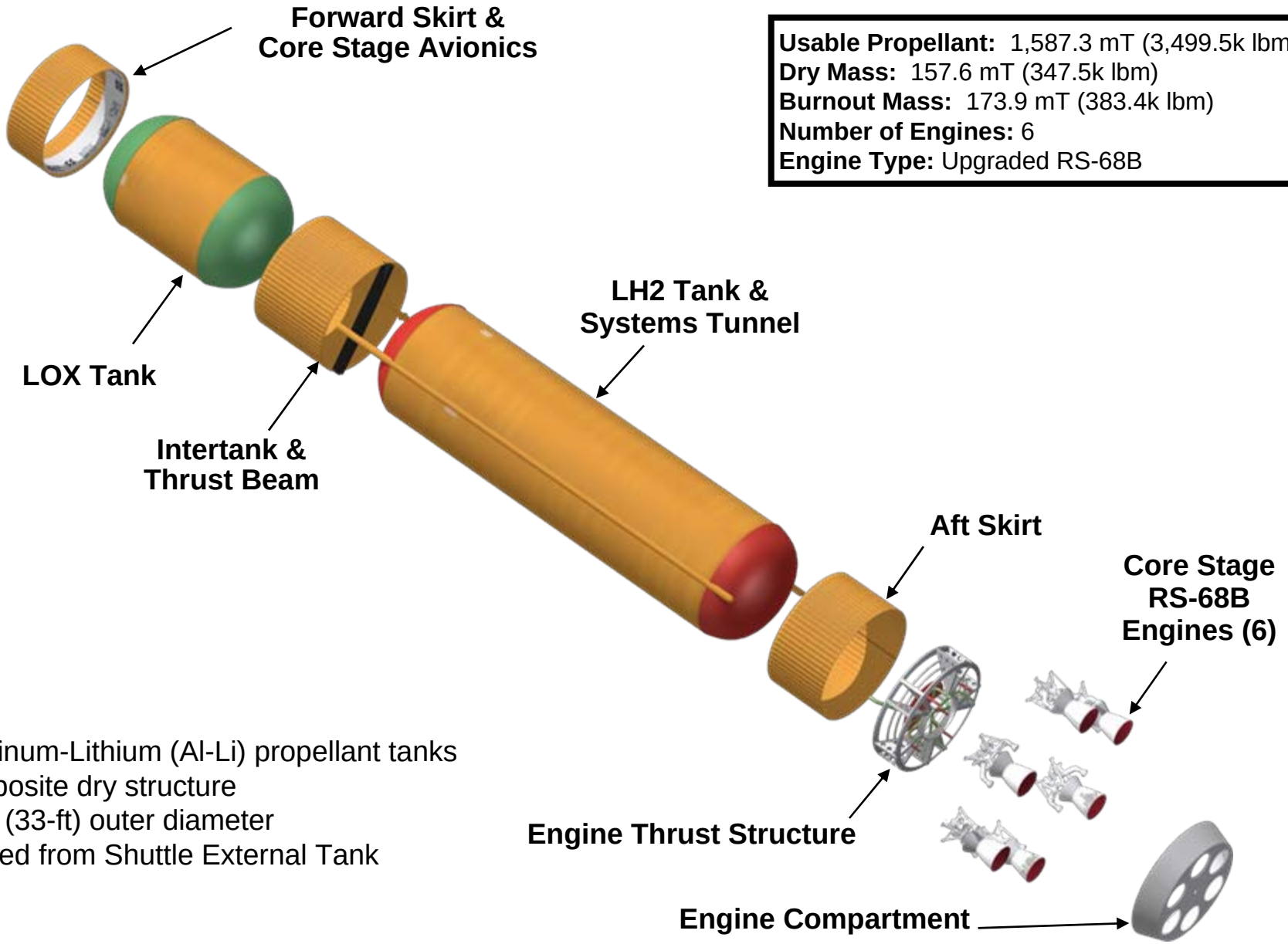
Metallic Nozzle Extension
- New design

Mass: 2.5 mT (5.5k lbm)
Thrust: 1.3M N (294.0k lbm) @ vac
Isp: 448 sec (vac)
Height: 4.7 m (185 in)
Diameter: 3.0 m (120 in)

Pratt & Whitney
A United Technologies Company
Pratt & Whitney Rocketdyne

Core Stage Design Concept

Expanded View



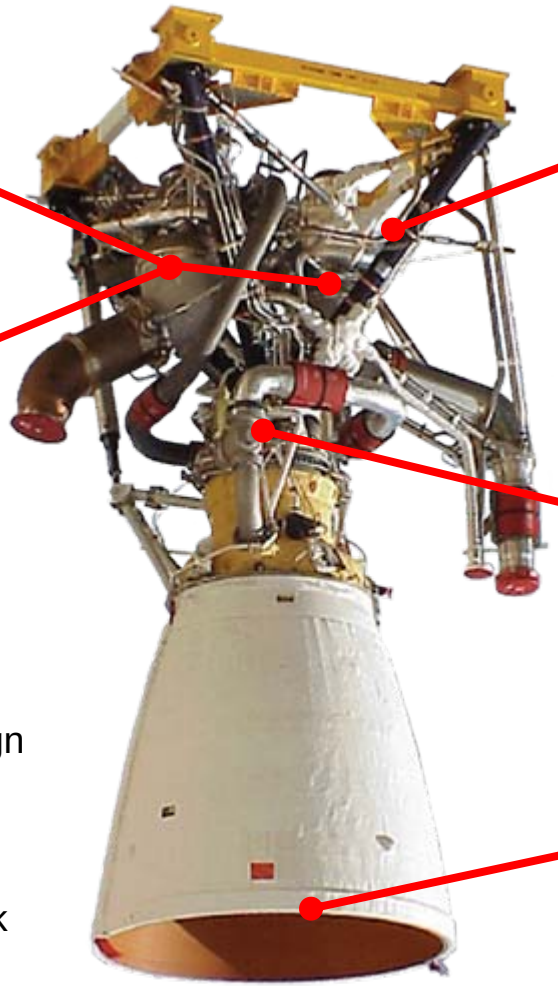
Usable Propellant: 1,587.3 mT (3,499.5k lbm)
Dry Mass: 157.6 mT (347.5k lbm)
Burnout Mass: 173.9 mT (383.4k lbm)
Number of Engines: 6
Engine Type: Upgraded RS-68B

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

Core Stage Upgraded USAF RS-68B Engine

* Redesigned turbine nozzles to increase maximum power level by ≈ 2%

Redesigned turbine seals to significantly reduce helium usage for pre-launch



Helium spin-start duct redesign, along with start sequence modifications, to help minimize pre-ignition free hydrogen

* Higher element density main injector improving specific impulse and thrust

Increased duration capability ablative nozzle

Other RS-68A upgrades or changes that may be included:

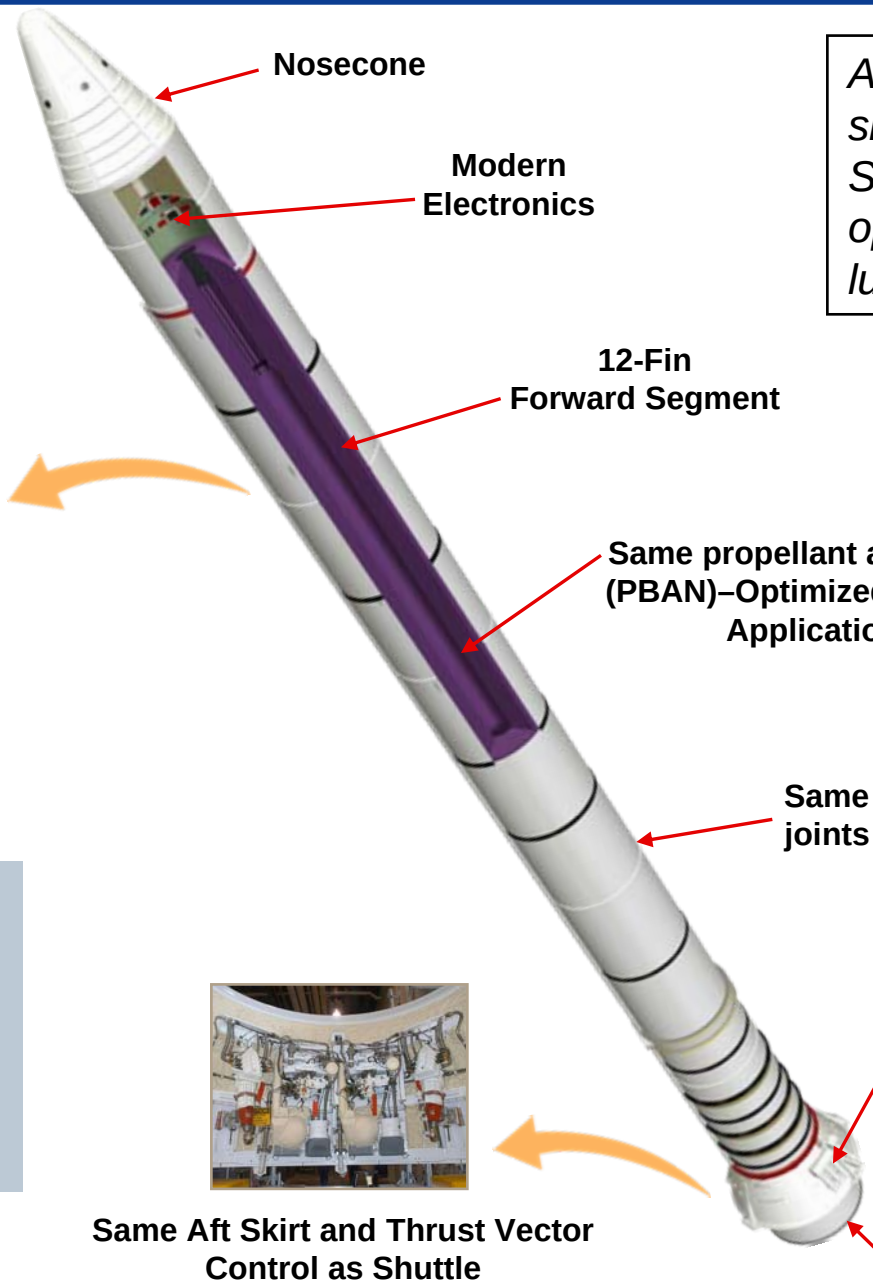
- Bearing material change
- New Gas Generator igniter design
- Improved Oxidizer Turbo Pump temp sensor
- Improved hot gas sensor
- 2nd stage Fuel Turbo Pump blisk crack mitigation
- Cavitation suppression
- ECU parts upgrade

* **RS-68A Upgrades**

Ares V (51.00.48)
Solid Rocket Booster (SRB)

ATK

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



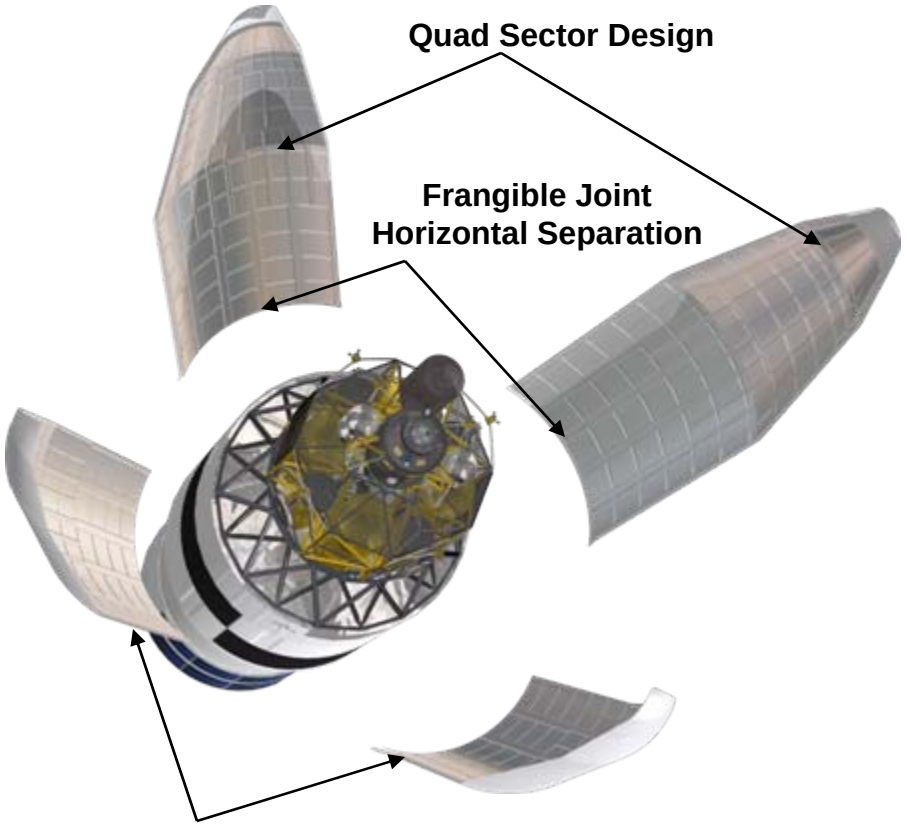
Same Aft Skirt and Thrust Vector Control as Shuttle

Mass: 794 mT (1.8M lbm)
Thrust: 15.8M N (3.5M lbf)
Burn Duration: 126 sec
Height: 55 m (180 ft)
Diameter: 3.7 m (12 ft)

Payload Shroud Point Of Departure

Point of Departure (Biconic) | **Leading Candidate (Ogive)**

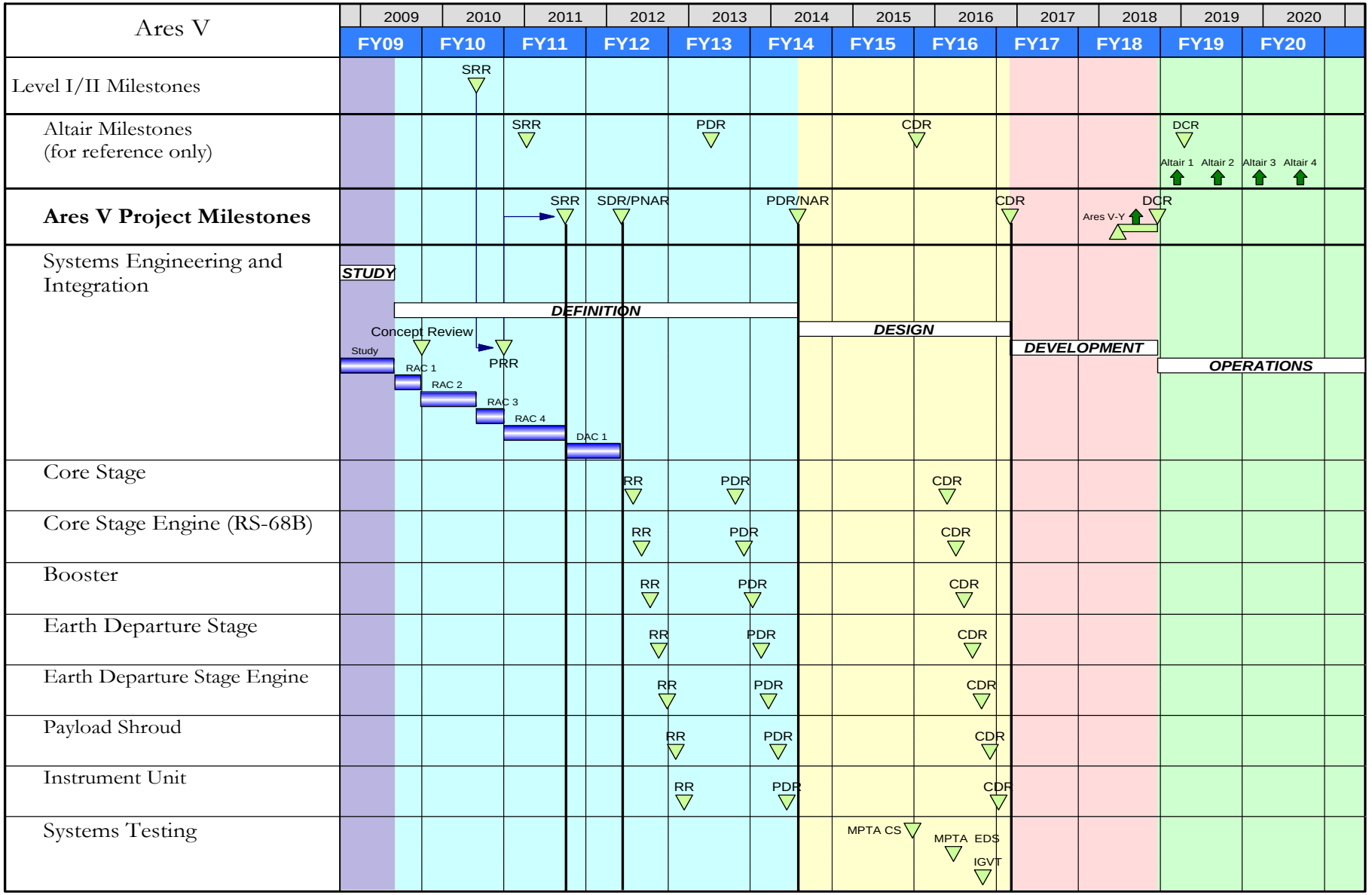
Mass: 9.1 mT (20.0k lbm)
POD Geometry: Biconic
Design: Quad sector
Barrel Diameter: 10 m (33 ft)
Barrel Length: 9.7 m (32 ft)
Total Length: 22 m (72ft)



- Composite sandwich construction (Carbon-Epoxy face sheets, Al honeycomb core)
- Painted cork TPS bonded to outer face sheet with RTV
- Payload access ports for maintenance, payload consumables and environmental control (while on ground)

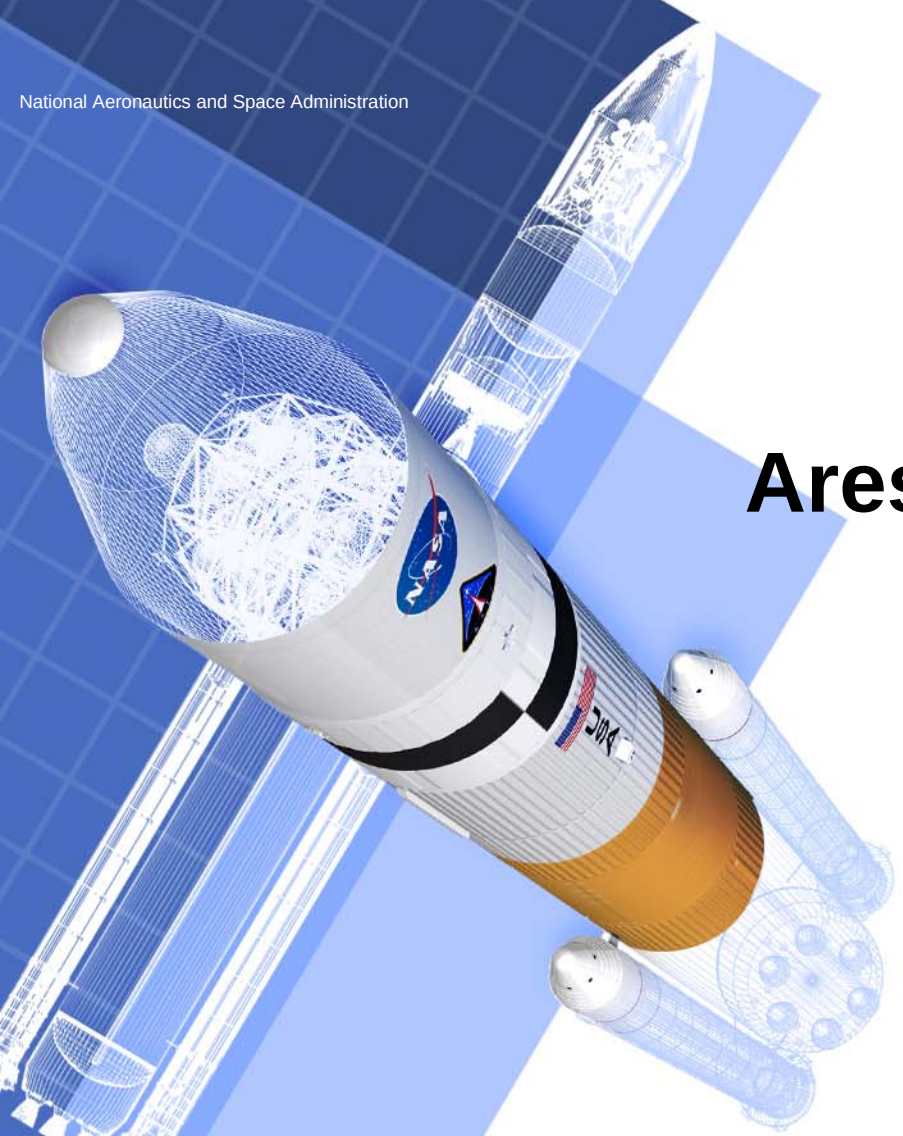
Thrust Rail Vertical Separation System
Payload umbilical separation

Ares V Summary Schedule



Current Ares V Status

- Current Ares V Point-of-Departure (51.00.48) exceeds Saturn mass capability by ~40%
- Ares V Lunar Capabilities Concept Review analysis focused on meeting lunar requirements and developing margin
- Ares V is sensitive to Loiter, Attitude, Power, and Altitude requirements in addition to payload performance
- LCCR-approved 51.00.48 POD 5.5-segment steel case booster/6 engine core) Ares V can meet current Human Lunar Return requirements with ~6 mT of Margin
- LCCR-approved 51.00.47 option maintained (5 segment HTPB composite case booster/6 engine core) can meet HLR requirement with more than 9 mT Margin
- Ares V team is actively reaching out to external organizations during this early concept phase to ensure that the Ares V vehicle can be leveraged for national security, scientific and commercial development needs



Ares V Mission Performance

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

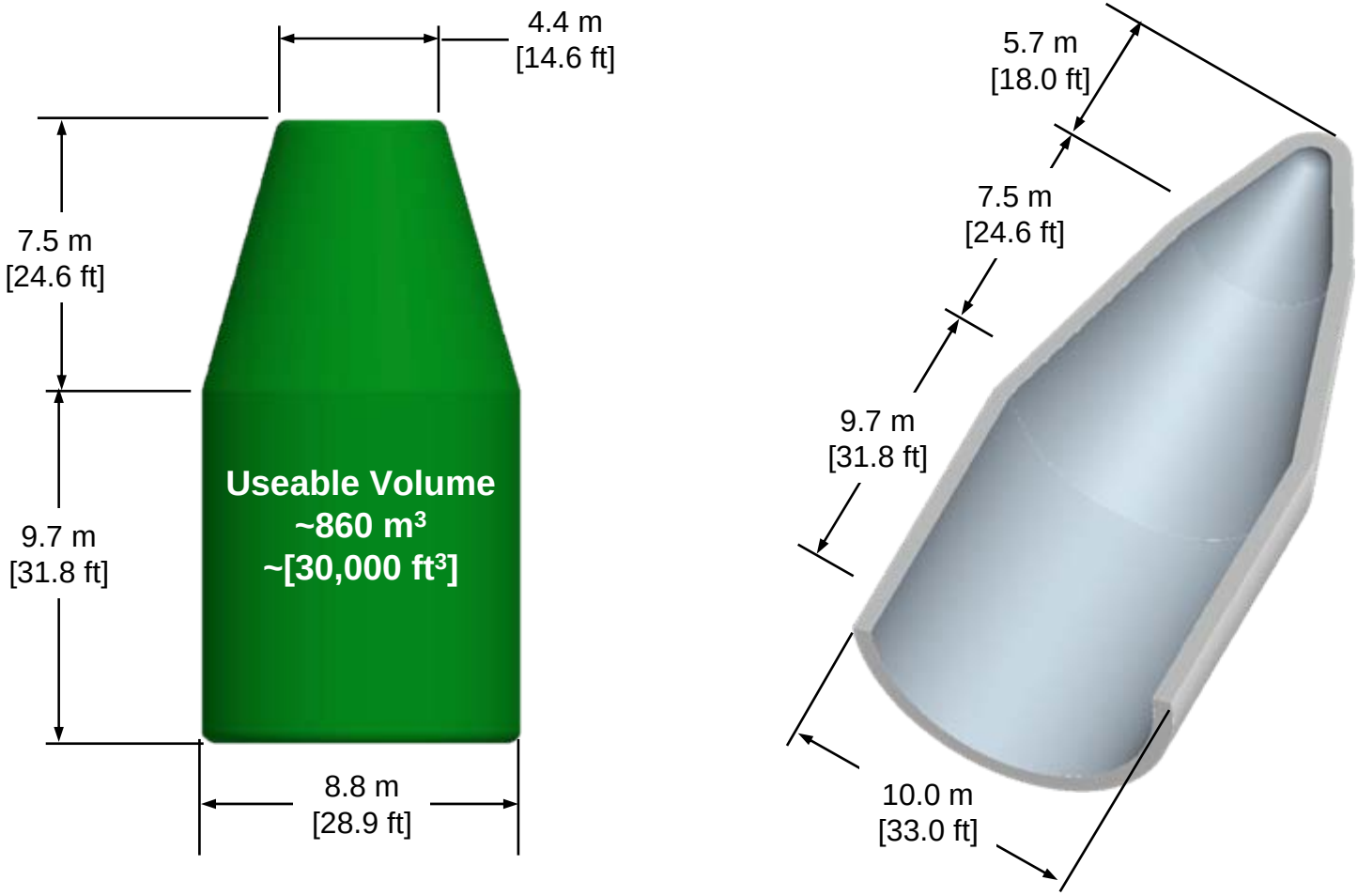
~185,000 kg to Low Earth Orbit
~60,000 kg to L2TO Orbit
10 meter Shroud

L2

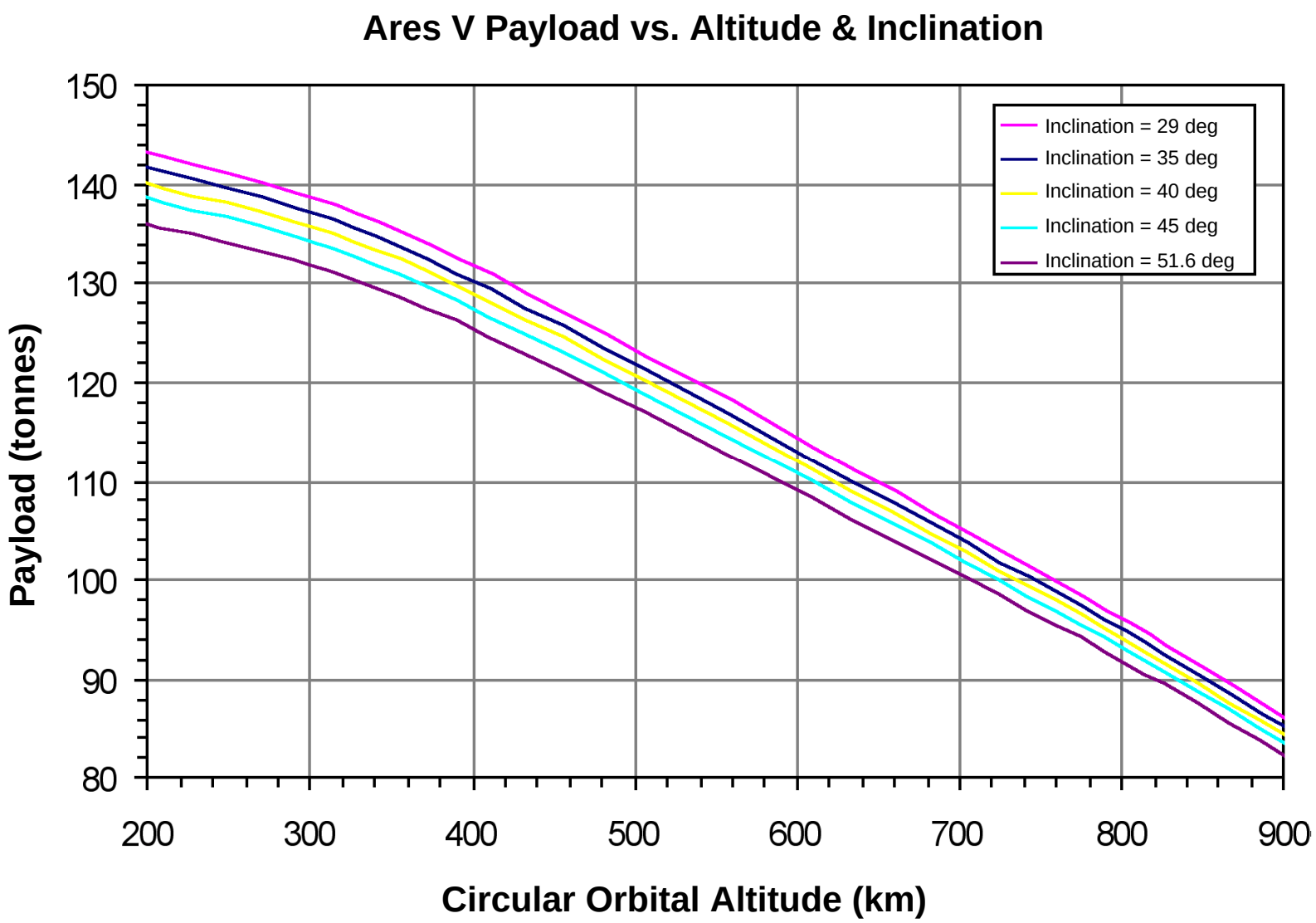
1.5 M km from Earth

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.

Shroud Point Of Departure Dimensions

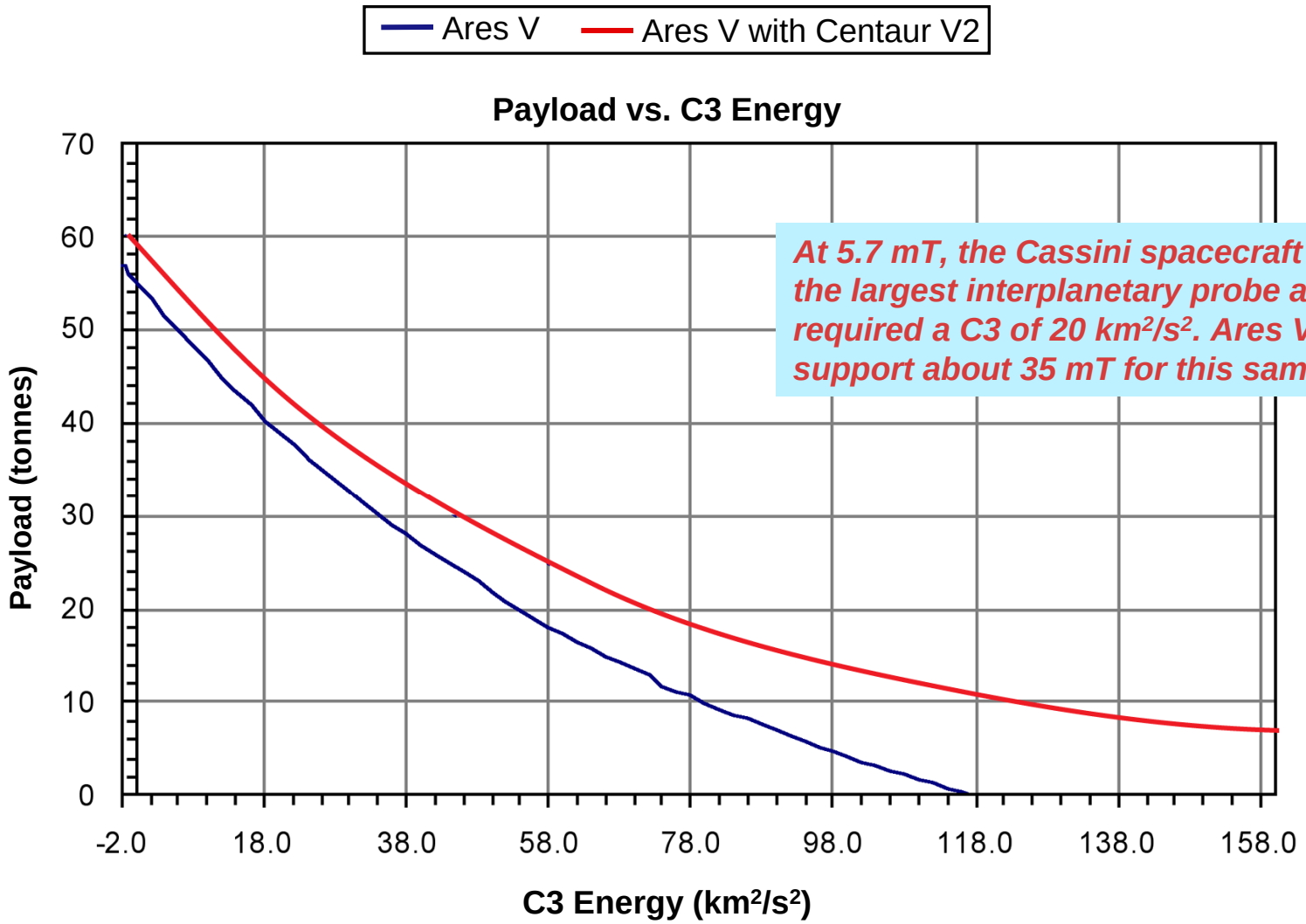


Ares V (51.00.39) LEO Performance



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.

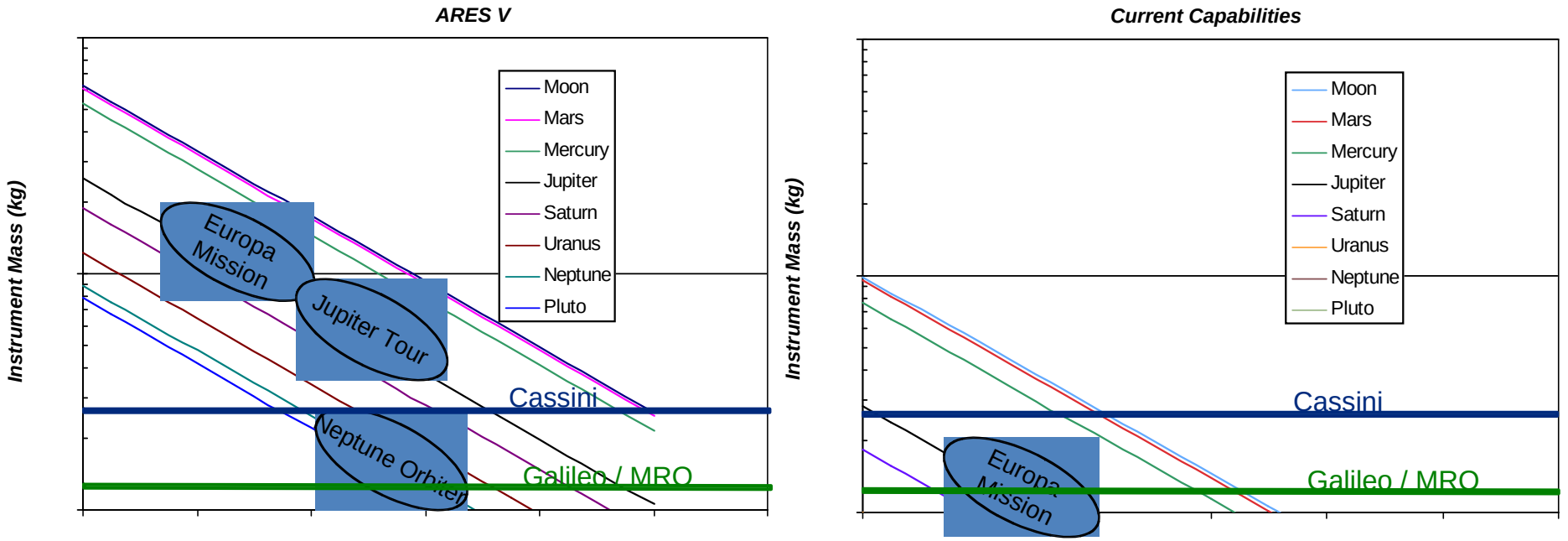
Ares V (51.00.39) Escape Performance



At 5.7 mT, the Cassini spacecraft is the largest interplanetary probe and required a C3 of 20 km²/s². Ares V can support about 35 mT for this same C3.

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 and Outer Planetary Science



The Ares V can support an order of magnitude more science instrumentation for outer planetary exploration missions

Can also reach outer planets such as Neptune and other high energy insertion destinations

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

- The focus of design efforts in the near future will be on the primary Lunar mission
- We are currently just beginning to integrate the design functions from the various centers for this mission
- We appreciate all thoughts and ideas for different ways to use the Ares V platform