Operational Concept for the NASA Constellation Program’s Ares I Crew Launch Vehicle

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Agenda

♦ Building on a Foundation of Proven Technologies
♦ Ares I Elements
♦ Orion Crew Exploration Vehicle
♦ Ares V Elements
♦ Key Ares I Operational Requirements
♦ Overall Ares I Operational Flow
♦ Example of Key Driving Requirement
♦ Operational Concept
♦ Summary
Building on a Foundation of Proven Technologies
– Launch Vehicle Comparisons –

**Space Shuttle**
- Height: 56.1 m (184.2 ft)
- Gross Liftoff Mass: 2,041,166 kg (4.5M lbm)
- 25 MT (55k lbm) to Low Earth Orbit (LEO)

**Ares I**
- Height: 99.1 m (325 ft)
- Gross Liftoff Mass: 907,185 kg (2.0M lbm)
- 25.6 MT (56.5k lbm) to LEO

**Ares V**
- Height: 109.7 m (360 ft)
- Gross Liftoff Mass: 3,374,910 kg (7.4M lbm)
- 63.6 MT (140.2k lbm) to TLI (with Ares I)
- 55.9 MT (123k lbm) to Direct TLI ~143.4 MT (316k lbm) to LEO

**Saturn V**
- Height: 110.9 m (364 ft)
- Gross Liftoff Mass: 2,948,350 kg (6.5M lbm)
- 45 MT (99k lbm) to TLI
- 119 MT (262k lbm) to LEO
Ares I Elements

Upper Stage
- 138k kg (305k lbm) LOX/LH₂ stage
- 5.5 m (18 ft) diameter
- Aluminum-Lithium (Al-Li) structures
- Instrument unit and interstage
- Reaction Control System (RCS) / roll control for first stage flight
- Primary Ares I control avionics system
- NASA Design

Instrument Unit
- Primary Ares I control avionics system
- NASA Design

Upper Stage Engine
- Saturn J–2 derived engine (J–2X)
- Expendable

Stack Integration
- 927k kg (2.0M lbm) gross liftoff weight
- 99 m (325 ft) in length
- NASA-led

First Stage
- Derived from current Shuttle RSRM/B
- Five segments/Polybutadiene Acrylonitrile (PBAN) propellant
- Recoverable
- New forward adapter
- Avionics upgrades

Orion CEV

Encapsulated Service Module (ESM) Panels

Instrument Unit

Interstage

Upper Stage Engine

DAC 2 TR 5
Orion Crew Exploration Vehicle

**Launch Abort System**

- **Attitude Control Motor**
  (Eight Nozzles)

- **Canard Section**
  (Stowed Configuration)

- **Jettison Motor**
  (Four Aft, Scarfed Nozzles)

- **Abort Motor**
  (Four Exposed, Reverse Flow Nozzles)

**Crew Module**

**Service Module**

**Encapsulated Service Module (ESM) Panels**

**Spacecraft Adapter**

**Volume**: 10.8 m³ (380 ft³)
- 80% larger than Apollo

**Diameter**: 5 m (16.5 ft)
Ares V Elements

Earth Departure Stage (EDS)
- One Saturn-derived J–2X LOX/LH₂ engine (expendable)
- 10 m (33 ft) diameter stage
- Aluminum-Lithium (Al-Li) tanks
- Composite structures
- Instrument unit and interstage
- Primary Ares V avionics system

Stack Integration
- 3.4M kg (7.4M lbm) gross liftoff weight
- 110 m (360 ft) in length

First Stage
- Two recoverable 5-segment PBAN-fueled boosters (derived from current Ares I first stage)

Core Stage
- Five Delta IV-derived RS–68 LOX/LH₂ engines (expendable)
- 10 m (33 ft) diameter stage

Vehicle 51.0.34
Key Ares I Operational Requirements

♦ Processed, integrated, and launched within 45 days.
♦ Capable of 6 launches per year.
♦ Interchangeable between International Space Station and Lunar missions.
♦ Launch probability not less than 95% due to natural environments and monthly weather conditions, during the period beginning with the decision to load cryogenic propellants and ending with the close of the day-of-launch window for the initial planned attempt.
♦ Probability of launching, beginning with decision to load cryogenic propellants, of not than 98% (excluding weather).
♦ Minimize launch pad processing time such that the Ares I is ready for launch within 7 days from arrival at the launch pad.
♦ Capable of a 24-hour turnaround following a launch scrub for a minimum of 7 consecutive days to support the 7-day lunar launch window.

Design in robustness and capabilities for operational solutions to off-nominal operations.
Example of Key Driving Requirement: Consecutive Launch Attempts for Ares I

Legend
- △ = Scrubbed Ares V attempt
- ✔ = Launched Ares V
- ✗ = Tanked/scrubbed Ares I due to Ares V launch scrub

- Ares I must tank for each Ares V launch attempt, plus for each of its own attempts after a successful Ares V launch, leading to a potential for 7 consecutive tankings of the Ares I before the missed Trans-Lunar Injection (TLI) window.
- Goal is to maximize launch attempts for TLI opportunity.
Summary

♦ Ares I design brings together innovation and new technologies with established infrastructure and proven heritage hardware to achieve safe, reliable, and affordable human access to space.

♦ NASA has 50 years of experience from Apollo and Space Shuttle.

♦ The Marshall Space Flight Center’s Mission Operations Laboratory is leading an operability benchmarking effort to compile operations and supportability lessons learned from large launch vehicle systems, both domestically and internationally.

♦ Ares V will be maturing as the Shuttle is retired and the Ares I design enters the production phase.
