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

Joel Best
Dr. Greg Chavers
Lea Richardson
Craig Cruzen

Engineering Directorate
NASA Marshall Space Flight Center
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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**

**Core Stage**
- (5 RS–68 Engines)
- **1,435,541 kg (3.2M lbm) LOX/LH₂**

**Upper Stage**
- (1 J–2X)
- **138,350 kg (302k lbm) LOX/LH₂**

**Earth Departure Stage (EDS) (1 J–2X)**
- **234,488 kg (517k lbm) LOX/LH₂**

**S-IIB**
- (5 J–2 engines)
- **453,592 kg (1M lbm) LOX/LH₂**

**S-IVB**
- (1 J–2 engine)
- **108,862 kg (240k lbm) LOX/LH₂**

**S-IC**
- (5 F–1)
- **1,769,010 kg (3.9M lbm) LOX/RP-1**

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

**Altair**
- **Height**: 110.9 m (364 ft)
- **Gross Liftoff Mass**: 2,948,350 kg (6.5M lbm)
- **45 MT (99k lbm) to TLI (with Ares I)**
- **55.9 MT (123k lbm) to Direct TLI**
- **~143.4 MT (316k lbm) to LEO**

**Overall Vehicle Height, m (ft)**
- **0 m (0 ft)**
- **30 m (100 ft)**
- **61 m (200 ft)**
- **91 m (300 ft)**
- **122 m (400 ft)**
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

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

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

Orion CEV

Encapsulated Service Module (ESM) Panels

Interstage
Orion Crew Exploration Vehicle

**Volume:** 10.8 m³ (380 ft³)  
- 80% larger than Apollo  
**Diameter:** 5 m (16.5 ft)

- **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**
Ares V Elements

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

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

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.
Overall Ares I Operational Flow

MSFC Ares I Responsibility
- Engine Assembly & Test-SSC
- J-2X Components
- Nozzle Extension
- Upper Stage w/ Integrated Interstage, J-2X, and Instrument Unit
- Michoud Assembly Facility
- Att Segment
- FWD & Center Segments
- Att Exit Cone
- BDMs, Forward Assembly & BTMs
- First Delivery FWD Skirt & Skirt Extension (Trade)

KSC Ground Operations Responsibility
- Launch Pad
- Transfer to Pad
- Vehicle Assembly Building
- Post Launch Mobile Launcher Refurbishment
- Ascent Operations (Responsibility of Mission Ops Project)
- Recovered CM
- First Stage
- First Stage Recovery
- Disassembly Hangar AF

Note: Conceptual Ground Ops Flow—Official Flow Owned by Ground Ops Project

Note: During DDT&E Phase (including three 5-segment flight tests), MSFC Exploration Launch Projects' First Stage Office will manage PRF, ARF, and RPSF operations. For steady state operations, MSFC First Stage Office will be responsible for sustaining engineering for PRF, ARF, and RPSF 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.
Operational Concept: Communications and Tracking Capability

- Launch MET=0
- FS Sep
- J2X Ignition
- TDRSS
- First Stage Separation
- First Stage Impact
- J2X Cutoff
- Upper Stage Separation
- Upper Stage Impact
- MOL Data Link Rates: 0.8 Mbps, 0.5 Mbps MEL Data
- MEL Data Link Rates: 12 Mbps Compressed Video
- DFI Data Link Rates: 20 Mbps DFI Data
- 12 Mbps, 192 Kbps, 192 Kbps, 12 Mbps Total
- 12.8 / 12.5 Mbps, 13 Mbps Max
- ~110 Kbps Orion Data, ~40 Kbps Ares Data
- ~192 Kbps, t > 6.5 min
- 20 Mbps Total
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.
