



Orion Launch Abort System (LAS) Propulsion on Pad Abort 1 (PA-1)

Daniel S. Jones

NASA Armstrong Flight Research Center
Aerodynamics & Propulsion Branch

Presented during the

SALUTE Event
Edwards AFB, CA
March 2nd, 2015

Approved for public release





Outline



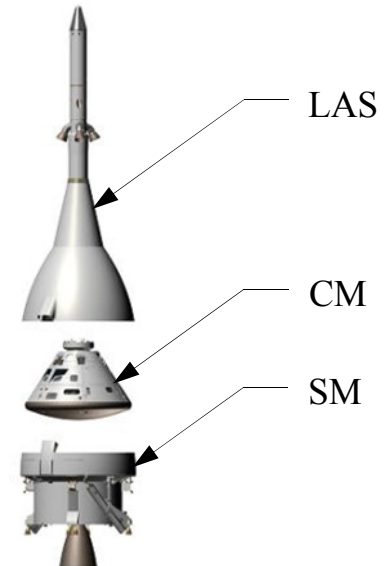
- Human Spaceflight
- Orion Pad Abort 1 (PA-1) Launch Abort System (LAS)
- Orion PA-1 LAS Abort Motor (AM)
- Orion PA-1 LAS Attitude Control Motor (ACM)
- Orion PA-1 LAS Jettison Motor (JM)
- Conclusion



Human Spaceflight Architecture and Certification



- The Space Launch System (SLS) architecture:
 - Designed to transport humans beyond low-Earth orbit (LEO), and take them further into our solar system than ever before
 - Will provide a transport capability to the International Space Station (ISS), as a backup for commercially developed vehicles
 - Includes the Orion Multi-Purpose Crew Vehicle (MPCV)
- The Orion MPCV includes:
 - Launch Abort System (LAS)
 - Crew Module (CM)
 - Service Module (SM)
- Orion Abort Flight Test (AFT) project:
 - Purpose: To conduct a series of flight tests in several launch abort scenarios to certify Orion LAS capability
 - Responsibility: The Orion Flight Test Management Office, at the NASA Johnson Space Center (JSC)
 - The Orion PA-1 flight-test vehicle integration and operations effort was led by the NASA Armstrong Flight Research Center (AFRC)
- The Orion Pad Abort 1 (PA-1) flight test:
 - Nationally recognized success for human spaceflight
 - The first fully integrated flight test of the Orion LAS
 - The success was made possible by numerous government and private sector organizations across the country
 - Required a significant contribution from the NASA AFRC workforce, in several areas of expertise





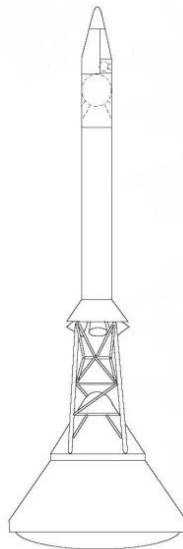
Orion Pad Abort 1 (PA-1) Launch Abort System (LAS)



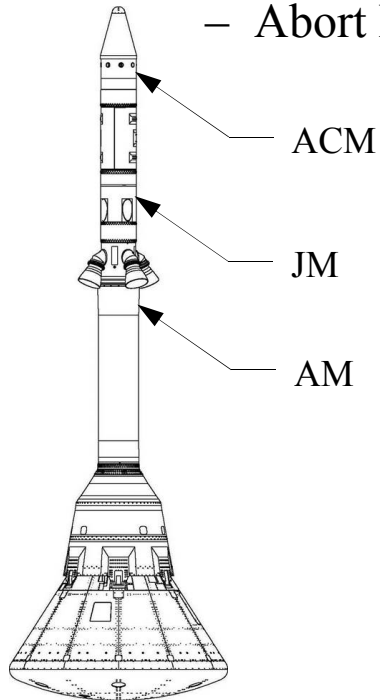
- Orion architecture and the initial AFT project flight test manifest had similarities with those of Apollo
- PA-1 tested the Launch Abort Vehicle (LAV), which is the Crew Module (CM) and LAS combined
- The LAS includes several subsystems, three of which are solid rocket motors:
 - Attitude Control Motor (ACM)
 - Jettison Motor (JM)
 - Abort Motor (AM)



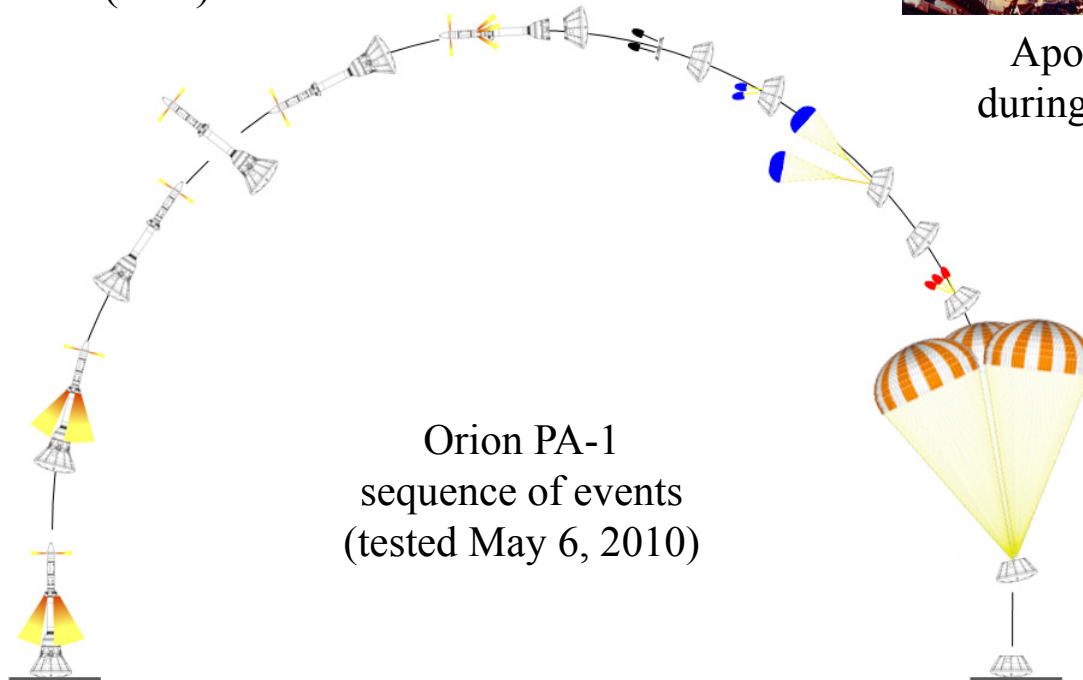
Apollo 11
during launch



Apollo



Orion LAV



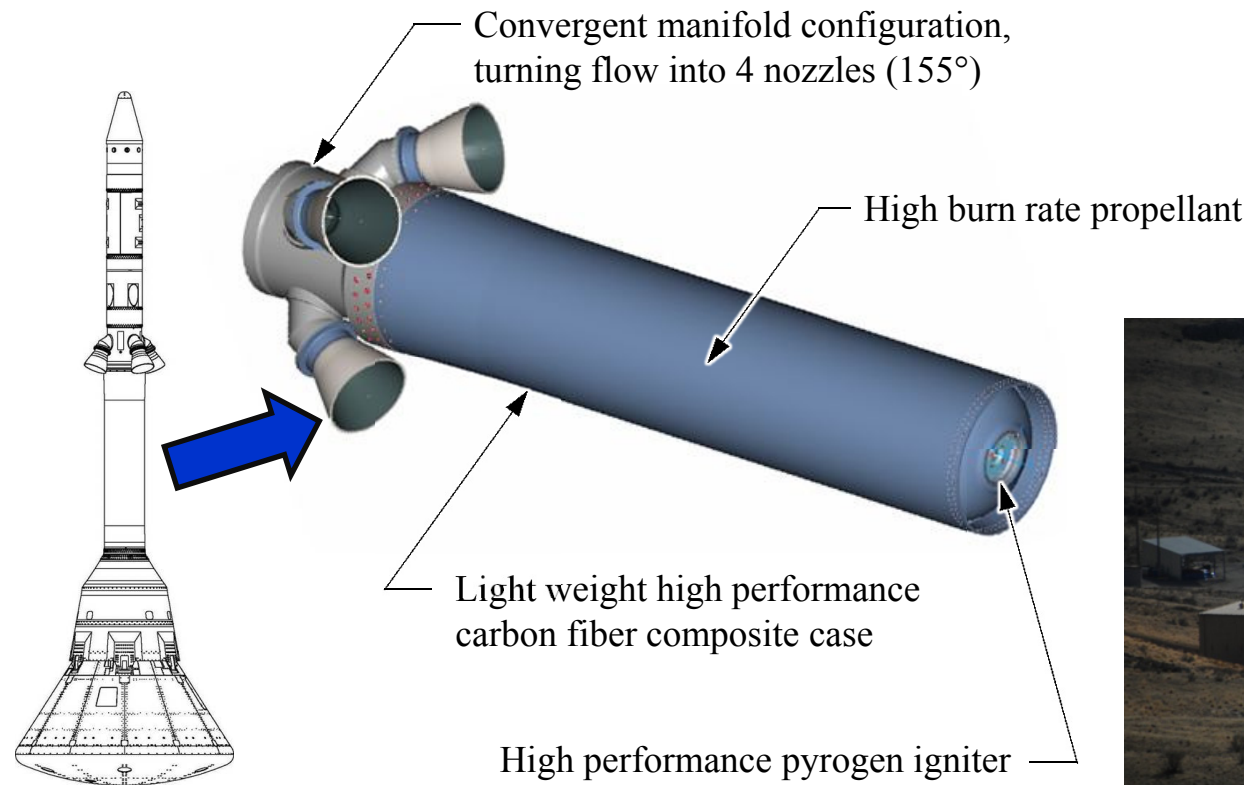
Orion PA-1
sequence of events
(tested May 6, 2010)



Orion PA-1 LAS Abort Motor (AM)



- Purpose: Provide the thrust force to propel the LAV safely away from a failed booster
 - Thrust is balanced between the desire to escape quickly and the human tolerance for acceleration
- Orion PA-1 LAS AM nominal design performance:
 - Maximum thrust: 500,000 lbf
 - Action time: 7 seconds
- Developed by: Orbital ATK, Utah



LAS AM Static Test 1

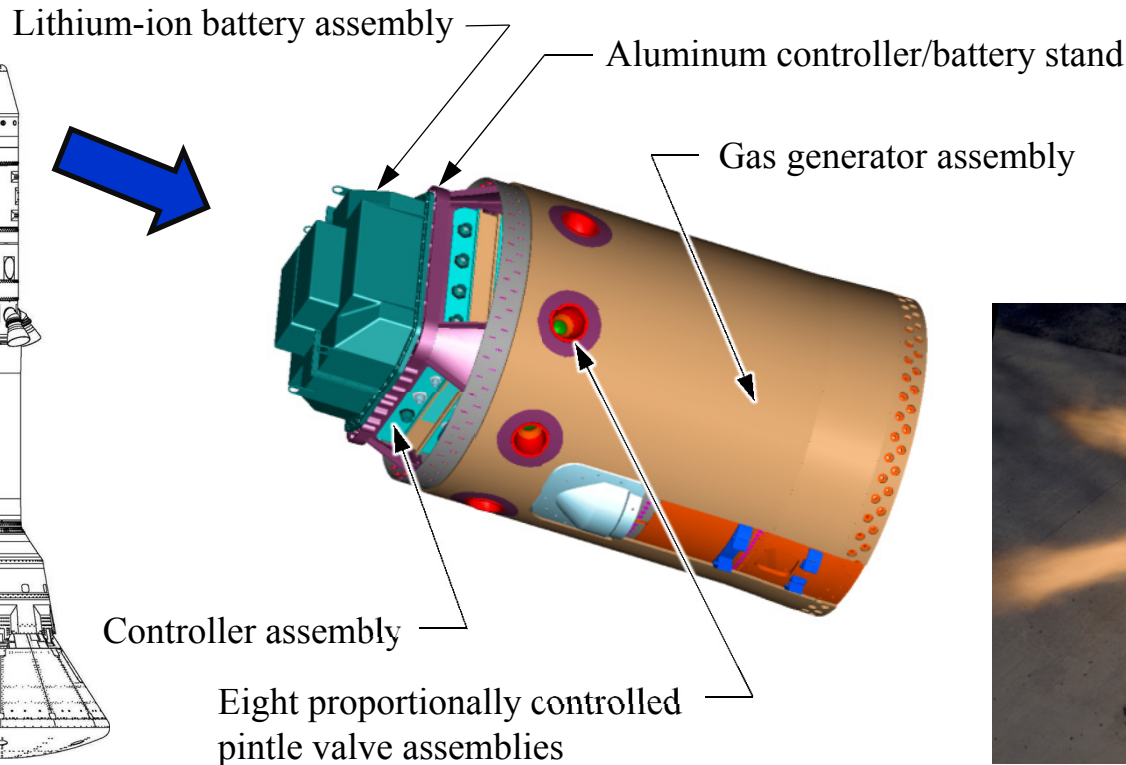
Orion LAV



Orion PA-1 LAS Attitude Control Motor (ACM)



- Purpose: Provide pitch and yaw control to optimize the LAV abort trajectory
 - Boost phase: Utilized for LAV directional control and stabilization
 - Sustain phase: Utilized to pitch-over and reorient the LAV
- Orion PA-1 LAS ACM nominal design performance:
 - Maximum thrust: 7,000 lbf
 - Maximum action time: 35 seconds
- Developed by: Orbital ATK, Elkton, Maryland





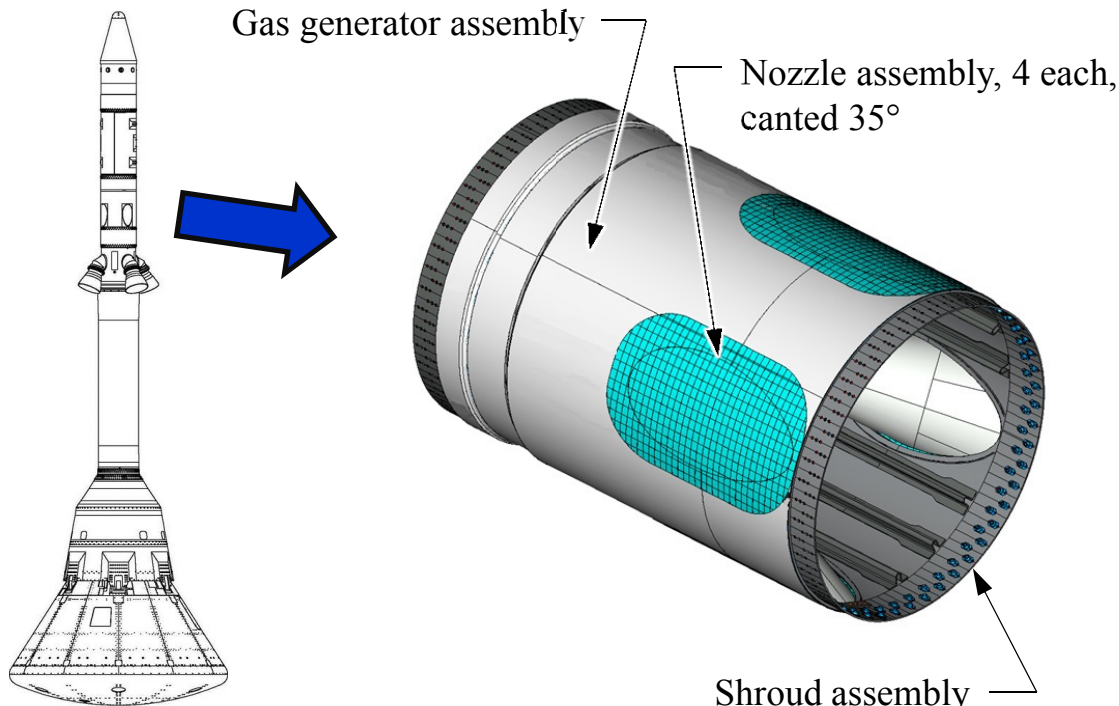
Orion PA-1 LAS Jettison Motor (JM)



- Purpose: Provide the thrust force required to jettison the LAS from the Orion CM
 - Abort scenario: Utilized after the AM and ACM have performed their functions
 - Nominal scenario: Utilized with fully loaded AM and ACM propellant
- Orion PA-1 LAS JM nominal design performance:
 - Maximum thrust: 44,000 lbf
 - Action time: 2 seconds
- Developed by: Aerojet Rocketdyne,
Sacramento, California



LAS JM
Demonstration Motor 2



Orion LAV



Conclusion



- The Orion LAS provides an abort capability in the unlikely event of a booster failure
 - The architecture of any spacecraft and launch vehicle requires the greatest level of safety
- The PA-1 flight test was a national accomplishment that required the dedication of numerous government and private sector organizations across the country
 - PA-1 required a significant contribution from the NASA AFRC workforce
- The Orion PA-1 LAS required the use of three propulsive subsystems
 - All three motors of the Orion LAS contributed to successfully demonstrating an abort capability from the launchpad





Acknowledgments and References



Acknowledgments

- Special Thanks to numerous individuals for content within this presentation, particularly from within:
 - NASA AFRC
 - NASA MSFC
 - NASA LaRC
 - NASA JSC
 - Lockheed Martin
 - Orbital ATK
 - Aerojet Rocketdyne

References

- For more detail on NASA AFRC, see:
 - “Armstrong Research, Technology, and Engineering Accomplishments 2014”
 - NASA/TM-2014-218336, available through ntrs.nasa.gov
- For more detail on Orion PA-1 propulsion, see:
 - “Executive Summary of Propulsion on the Orion Abort Flight-Test Vehicles”
 - NASA/TM-2012-216049, available through ntrs.nasa.gov
 - AIAA 2012-3891, available through arc.aiaa.org
- For video highlights of the Orion PA-1 flight test, see:
 - <http://www.youtube.com/watch?v=wzIcDDJyTRI>