



NASA's Ares I Upper Stage

Powering the Second Phase of a Rocket's Journey to Space

Going to the moon and beyond will be a stunning achievement and an enduring legacy to future generations. Supporting the agency's mission to explore, learn and progress is NASA's Ares I crew launch vehicle, an in-line, two-stage rocket. The flagship of the Constellation Program's space transportation system, the Ares I will carry the Orion spacecraft and its crew on missions to the International Space Station and then later on to the moon and beyond.

Taking the Ares I on the second phase of its journey from Earth will be the spacecraft's second, or upper, stage, powered by the J-2X engine. Approximately 133 seconds after liftoff, the Ares I upper stage will separate from the vehicle's first stage, and the J-2X will ignite. The engine will operate for approximately 465 seconds, burning more than 102,600 gallons (302,200 pounds) of propellant. It will shut down just as the Ares I upper stage reaches an altitude of 439,700 feet (83 miles).

Shortly after J-2X engine cutoff, the Orion capsule will separate from the upper stage. Orion's engine then will ignite to insert the capsule into low-Earth orbit. The Ares I upper stage – dormant after safe shut-down of the J-2X upper stage engine – will re-enter Earth's atmosphere and splash down in the Indian Ocean. The upper stage and J-2X engine will not be reused.

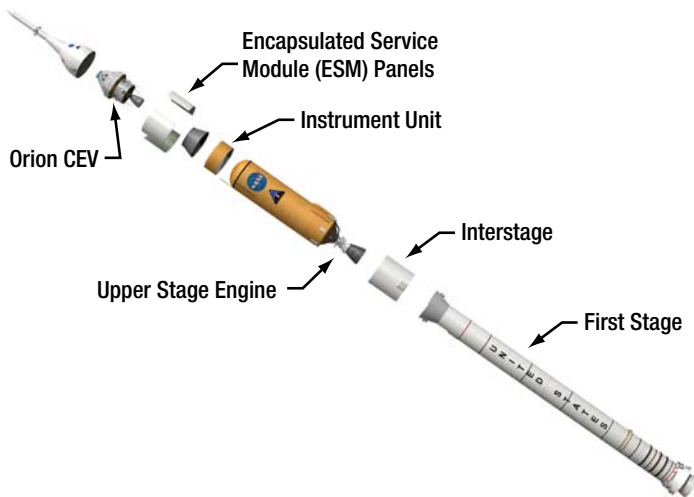
Upper Stage Components

The entire Ares I vehicle will be 325 feet tall, with a liftoff mass of 2.0 million pounds and payload capacity of 56,200 pounds mass to low Earth orbit for International Space Station missions, and 55,600 pounds mass for lunar missions. A self-supporting cylindrical structure, the Ares I upper stage will be approximately 18 feet in diameter and 84 feet long. On the launch pad, the upper stage – including the J-2X engine – will account for approximately one-quarter of the total height of the Ares I.



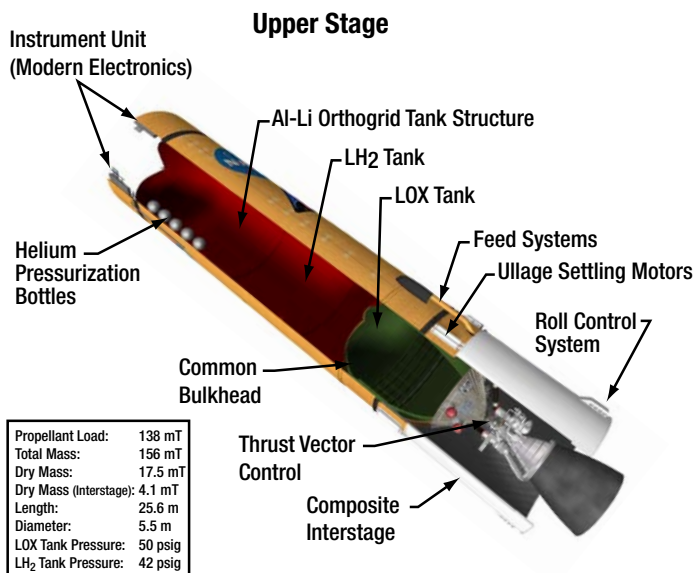
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Ares I Elements



The largest components of the upper stage will be two insulated tanks – one for liquid hydrogen and another for liquid oxygen. These two propellant tanks will be separated by an internal partition called the common bulkhead. Located within the upper stage tank assembly, this bulkhead will not only physically divide the liquid hydrogen from the liquid oxygen, but also maintain the pressure difference between the two tanks.

Located between the Ares I instrument unit and the common bulkhead, the liquid hydrogen tank will measure approximately 611 inches, or nearly 51 feet, long. Fabricated from an aluminum-lithium alloy, the tank will provide storage for 11,620 cubic feet of unpressurized fuel at minus 423° F, or 11,800 cubic feet of unpressurized fuel at 72° F. Friction stir welding technology will also be used for all weld joints.



Located on the other side of the common bulkhead is the liquid oxygen tank, which provides insulated storage for the J-2X engine's oxidizer – the liquid oxygen that will enable the hydrogen to burn without drawing in outside air. The tank, also fabricated from an aluminum-lithium alloy, will measure approximately 108 inches, or more than 9 feet, long. It will provide 3,825 cubic feet of unpressurized, liquid storage volume at minus 297° F, or 3,868 cubic feet of unpressurized, liquid storage volume at 72° F.

The Ares I upper stage also will provide the guidance, navigation and control needed to complete the second phase of the Ares I ascent flight after the first stage separates from the launch vehicle. The thrust vector control system will provide the force and control to “gimbal” the J-2X engine nozzle for thrust vector control and vehicle steering. A gimbal is a pivoted support that allows the rotation of an object about a single axis.

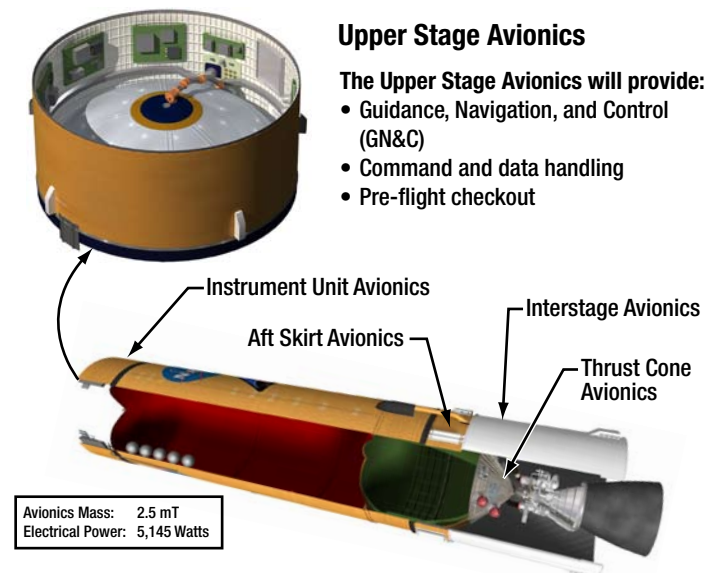
Other components of the upper stage include upper stage reaction control, separation and avionics systems, and first stage roll control system. The reaction control and roll control systems will direct the vehicle's roll and attitude during ascent. The separation systems will disconnect the first stage from the upper stage. The avionics system will provide most of the avionics and supporting hardware and software necessary to control the Ares I during all phases of ground processing and flight.

Most of the avionics will be housed in the instrument unit that provides the mechanical and electrical interfaces between the Ares I launch vehicle and the crew exploration vehicle. Commonly referred to as the “brains of the

Upper Stage Avionics

The Upper Stage Avionics will provide:

- Guidance, Navigation, and Control (GN&C)
- Command and data handling
- Pre-flight checkout

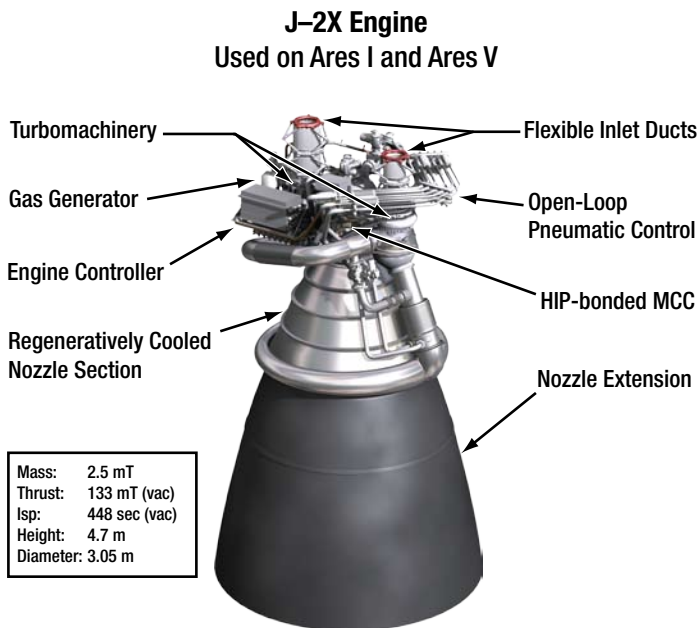


vehicle,” the instrument unit serves as the structural interface between the Ares I core stage and Orion spacecraft adapter. Measuring 86 inches in length and 216.5 inches in diameter, the instrument unit contains the majority of Ares I avionics and provides the mechanical and electrical interfaces between Orion and Ares I.

About the J-2X Engine

The Ares I upper stage will provide fuel for one J-2X engine. The J-2X is an evolved variation of two historic predecessors: the powerful J-2 upper stage engine that propelled the Apollo-era Saturn IB and Saturn V rockets to the moon in the 1960s and 1970s; and the J-2S, a simplified version of the J-2 developed and tested, but never flown, in the early 1970s.

Fueled with liquid oxygen and liquid hydrogen, the J-2X will deliver 294,000 pounds of thrust. Roughly 15 feet, 5 inches long and 10 feet wide, it will weigh approximately 5,450 pounds.



NASA Partnerships

Using NASA's design, the Ares I upper stage will be fabricated by an industry partner, The Boeing Co., at the Michoud Assembly Facility in New Orleans. NASA awarded Boeing this contract in August 2007 as part of an agreement that includes the assembly, checkout and delivery of the completed integrated upper stages. Boeing also won the contract for the upper stage instrument unit avionics (IUA).

The final integrated upper stage, along with its delivery and operation, will be the product of numerous other partnerships among industry and NASA. Throughout the life of the upper stage element, NASA will maintain data rights for the design and the resulting upper stage hardware.

Along with NASA Headquarters in Washington and NASA's Marshall Center, the NASA upper stage team includes Ames Research Center in Moffett Field, Calif.; the Glenn Research Center in Cleveland; the Johnson Space Center in Houston; the Michoud Assembly Facility in New Orleans; the Kennedy Space Center, Fla.; the Langley Research Center in Hampton, Va.; and Stennis Space Center in Bay St. Louis, Miss.



The Michoud Assembly Facility in New Orleans is an 832-acre site managed by NASA's Marshall Space Flight Center in Huntsville, Ala. The facility includes one of the world's largest manufacturing plants with 43 acres under one roof and a port with deep-water access—a capability providing for transportation of large space systems and hardware.

Ares Projects Office

The Ares Projects Office is managed by the Marshall Center for NASA's Exploration Systems Mission Directorate in Washington. The projects office answers directly to the Constellation Program Office at NASA's Johnson Space Center.

The Ares I effort incorporates project teams, hardware development, evolution of proven technologies and component and system testing at NASA centers and contract organizations around the nation.

For more information on the Web about the Ares I launch vehicle, visit:

www.nasa.gov/ares

For more information on the Web about the Constellation Program, visit:

www.nasa.gov/constellation

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National Aeronautics and Space Administration

George C. Marshall Space Flight Center

Huntsville, AL 35812

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