Ares I (Crew Launch Vehicle)

Outlook

- Ares I-X launched in October 2009
- FY 2011 NASA budget request proposed terminating the Constellation program, and with it, the Ares I launch vehicle
- NASA proposal to cancel Constellation program met with stiff resistance in Congress
- NASA will study technologies for a future heavy-lift launch vehicle with the goal of beginning development in 2015

Orientation

Description. Ares I is the next-generation U.S. crew launch vehicle.

Sponsor. The Exploration Launch Projects Office at NASA's Marshall Space Flight Center, Huntsville, Alabama, manages efforts on the Ares I. Marshall reports to the Constellation Program Office at Johnson Space Center, Houston, Texas.

Status. In development. Congress is debating the fate of the Ares I after President Barack Obama proposed terminating the program in the FY2011 budget. If development continues, the launch vehicle is expected to enter service around 2015.

Total Produced. One

Application. Ares I is being developed to launch the Orion spacecraft, also known as the Crew Exploration Vehicle (CEV), for the Constellation Program. Preliminary missions with Ares I will be to the International Space Station (ISS). Up to six crew members could be carried to the ISS, or the rocket could be launched unmanned to maximize cargo. Landing on the Moon and Mars will be the goal of future missions. For lunar missions, Ares I will launch Orion with four crew members into a low-Earth orbit, where they will rendezvous with the Earth Departure Stage (EDS) of an Ares V. Once joined, the EDS will push Orion toward the Moon.

Price Range. Current estimates place the cost of launching an Ares I at approximately $400 million.

Contractors

Prime

Chickasaw Nation Industries	http://www.chickasaw.com/, 2600 John Saxon Blvd, Norman, OK 73071 United States, Tel: + 1 (405) 253-8200, Program Participant (Logistics and Inventory Control)
Marshall Space Flight Center, MSFC	http://www.msfc.nasa.gov, Bldg 4200, Rm 120, Huntsville, AL 35812 United States, Tel: + 1 (205) 544-2121, Fax: + 1 (205) 544-5852, Prime

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United Launch Alliance, ULA	http://www.ulalaunch.com, 9100 E Mineral Cir, Centennial, CO 80112 United States, Tel: + 1 (720) 922-7100, Email: contact.us@ulalaunch.com, RDT+E (Development)
United Space Alliance LLC	http://www.unitedspacealliance.com, 1150 Gemini St, Houston, TX 77058 United States, Tel: + 1 (281) 212-6000, RDT+E (Operations Design)

Subcontractor

Aerojet, Redmond Operations	http://www.aerojet.com, 11411 139th Place N.E., Redmond, WA 98052 United States, Tel: + 1 (425) 885-5000 (Roll Control System; Ares I Upper Stage)
Alcoa North American Rolled Products, Davenport Works	http://www.alcoa.com/locations/usa_davenport/en/home.asp, 4879 State St, Riverdale, IA 52722 United States, Tel: + 1 (563) 459-2001 (High Performance Aluminum-Lithium Plate and Ingot)
Alliant Techsystems - Aerospace Systems, Aerospace Structures	http://www.atk.com, 1700 North Research Park Way, Logan, UT 84341 United States, Tel: + 1 (435) 753-8565 (RS-68 Nozzle)
Alliant Techsystems - Armament Systems	http://www.atk.com, 938 University Park Blvd, Clearfield, UT 84015 United States, Tel: + 1 (763) 712-7700, Email: businessdevelopment@atk.com (Five Segment SRBs)
American Tank and Vessel, Inc	http://www.at-v.com/, 15915 Freeway, Suite 290, Houston, TX 77094 United States, Tel: + 1 (281) 492-7778, Fax: + 1 (281) 492-7667, Email: tanks@at-v.com (Test Cell Diffuser)
Andrews Space Inc	http://www.andrews-space.com, Suite 300, 505 Fifth Ave South, Seattle, WA 98104 United States, Tel: + 1 (206) 438-0615, Fax: + 1 (206) 342-9938, Email: info@andrews-space.com (Ares I First Stage)
Ball Aerospace & Technologies Corp	http://www.ballaerospace.com, 1600 Commerce St, PO Box 1062, Boulder, CO 80306 United States, Tel: + 1 (303) 939-4000, Fax: + 1 (303) 939-6104, Email: info@ball.com (Command Telemetry and Flight Computers)
Boeing Defense, Space & Security	http://www.boeing.com, PO Box 516, St Louis, MO 63166 United States, Tel: + 1 (314) 232-0232, Fax: + 1 (314) 777-1096 (Instrument Unit Avionics; Ares I Upper Stage)
Booz Allen Hamilton	http://www.bah.com, 8283 Greensboro Dr, McLean, VA 22102 United States, Tel: + 1 (703) 902-5000 (Ares I Vehicle Integration)
Charles Stark Draper Laboratory Inc	http://www.draper.com, 555 Technology Sq, Cambridge, MA 02139-3563 United States, Tel: + 1 (617) 258-1000, Fax: + 1 (617) 258-1131 (Ares I Vehicle Integration)
Eaton Aerospace - Electrical Sensing & Controls	http://www.aerospace.eaton.com, 15 Durant Ave, Bethel, CT 06801 United States, Tel: + 1 (203) 796-6000, Fax: + 1 (203) 796-6313 (Upper Stage Engine)
Ensign-Bickford Industries Inc	http://www.ensign-bickfordind.com, 100 Grist Mill Rd, POB 7, Simsbury, CT 06070 United States, Tel: + 1 (860) 843-2000 (Ares I Upper Stage)
Goodrich Interiors, Propulsion Systems	http://www.goodrich.com, 3530 Branscombe Rd, PO Box KK, Fairfield, CA 94533 United States, Tel: + 1 (707) 422-1880, Fax: + 1 (707) 422-3242 (Ares I First Stage)
Hamilton Sundstrand Space & Undersea Systems	http://www.hsspace.com, One Hamilton Rd, Windsor Locks, CT 06096 United States, Tel: + 1 (860) 654-3455, Fax: + 1 (860) 654-5515 (Ares I Upper Stage; Thrust Vector Control System)
Honeywell Aerospace, Defense & Space Electronic Systems	http://www.honeywell.com/sites/aero/, 13350 US Hwy 19 N, Clearwater, FL 33764-7290 United States, Tel: + 1 (727) 539-4801 (Upper Stage Engine)
Jacobs Engineering	http://www.jacobs.com/, 1111 South Arroyo Parkway, PO Box 7084, Pasadena, CA 91109 United States, Tel: + 1 (626) 578-3500, Fax: + 1 (626) 568-7144 (Ares I Upper Stage)
L-3 Communications - Cincinnati Electronics Inc	http://www.cinele.com, 7500 Innovation Way, Mason, OH 45040-9699 United States, Tel: + 1 (513) 573-6100 (Avionics Boxes)
Magellan Aerospace Turbine Serivces	http://www.magellanats.com, 5170 W Bethany Home Rd, Glendale, AZ 85301 United States, Tel: + 1 (623) 931-0010, Fax: + 1 (623) 931-7264 (Upper Stage Engine)
Moog Inc, Torrance Operations	http://www.moog.com/, 20263 Western Ave, Torrance, CA 90501 United States, Tel: + 1 (310) 533-1178, Fax: + 1 (310) 618-6660, Email: sdgsales@moog.com (Main Propulsion Components; Reaction Control System Components; Ares I Upper Stage)

Northrop Grumman Space Technology	http://www.as.northropgrumman.com, 1 Space Park, Redondo Beach, CA 90278 United States, Tel: + 1 (310) 812-4321, Fax: + 1 (310) 813-7548 (Upper Stage Composite Interstage)
Orion Propulsion Inc	http://www.orionpropulsion.com/, 1525 Perimeter Parkway, Suite 250, Huntsville, AL 35806 United States, Tel: + 1 (256) 327-7600, Fax: + 1 (256) 327-7605 (Reaction Control System Thruster Test Equipment)
Pratt & Whitney Rocketdyne	http://www.pratt-whitney.com, 6633 Canoga Ave, Canoga Park, CA 91309 United States, Tel: + 1 (818) 586-3829, Fax: + 1 (818) 586-6155 (J-2X Upper Stage Engine; RS-68 Engine)
Summa Technology Inc	http://www.summa.com, 140 Sparkman Drive, Huntsville, AL 35805 United States, Tel: + 1 (256) 830-7000 (Large Barrel Panels for Upper Stage)
Teledyne Brown Engineering Inc	http://www.tbe.com, Cummings Research Park, PO Box 070007, Huntsville, AL 35807-7007 United States, Tel: + 1 (256) 726-5555, Fax: + 1 (256) 726-5556, Email: publicrelations1@tbe.com (Ares I Upper Stage)

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Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

Design Features. The Ares I is designed to be an in-line two-stage rocket, topped by the Orion spacecraft, Orion's service module, and a launch abort system.

First Stage. The Ares I first stage is approximately 165 feet in length. Its responsibility is to lift the entire Ares I launch and crew vehicle stack, or about two million pounds, off the ground toward Earth orbit. The first stage element comprises a five-segment solid rocket booster. It includes a parachute recovery system, deployed for safe recovery of the booster and motor components for post-flight evaluation and reuse. A forward skirt and frustum mates the first stage with the upper stage element of the launch vehicle.

Also included are the avionics systems, such as communications and navigation controls located near the top of the first stage, and the aft skirt, which is made of aluminum.

Five-Segment Solid Rocket Booster. The Ares I first stage element is derived from the Space Shuttle. The primary difference is that Ares I uses a single five-segment solid rocket booster with motor. The shuttle uses two, four-segment reusable solid rocket boosters with motors. The Ares I fifth booster segment allows the launch vehicle to lift more weight and reach a higher altitude before the first stage separates from the upper stage, which ignites in mid-flight to propel the Orion spacecraft to Earth orbit. The Ares I solid rocket motor burns polybutadiene acrylonitrile, or PBAN, a shaped solid propellant.

Ares I also will use existing shuttle hardware – the steel cases – to hold the propellant. The thrust or power needed to lift the launch vehicle off the ground is achieved by igniting highly-configured propellant "fins" inside the first booster segment, similar to the operation of the shuttle boosters and motors. These fins are created by pouring the propellant into an insulated and lined segment containing grain core tooling. The propellant fins in the forward segment provide surface area to burn with a precisely controlled release of energy in the form of thrust. The interior shape of the other four segments is smooth, providing a long, hollow tube for carrying propellant smoothly toward the nozzle at the aft end.

The added fifth segment on the Ares I solid rocket booster provides additional propellant mass and surface area to burn, providing even more thrust. This additional performance allows the launch vehicle to lift more weight, or payload, and fly higher. To accommodate the additional fifth segment, certain features of the shuttle reusable solid rocket motor will be modified to suit the Ares I first stage design. The motor's nozzle throat, for example, is 3 inches wider in diameter. The nozzle will be manufactured using similar metallic materials and will perform the same functions, such as gimballing – a pivoting or swiveling mount – to move the motor nozzle, allowing the motor to point in different directions to control the vehicle's flight path.

The bigger nozzle throat allows the motor to handle the additional thrust from the five-segment booster, and meets NASA requirements to stay within the pressure capacity of the existing steel cases. New insulation and

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rubber liner materials are also being used. These materials are more environmentally friendly and provide the thermal protection required for the steel case hardware.

Second Stage (Upper Stage). 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.

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.

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.

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 will also 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.

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 vehicle," the instrument unit (built by Boeing) 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.

The astronauts aboard an Ares I will experience a maximum of 3.25-3.5 times the force of gravity during launch, compared with the 3*g* maximum force felt by those on the shuttle. The new rocket will reach MaxQ, the period of maximum aerodynamic pressure, roughly 58 seconds into its flight. By then, Ares I will be 40,000 feet above the ground traveling at Mach 1.6. Roll-control will come from a new Reaction Control System (RCS), based on the Post-Boost Propulsion System (PBPS) made by Rocketdyne for the Peacekeeper Intercontinental Ballistic Missile.

The new RCS will use 72 small hypergolic thrusters using monomethylhydrazine fuel and nitrogen tetroxide oxidizer. Engineers are still unsure about the specifics of controlling steering and roll during flight, though they are carefully studying the issue. When the SRB is disconnected, it will fall toward Earth at speeds up to Mach 6, whereas the shuttle's boosters currently fall at a speed of Mach 4. Engineers are currently looking at ways of tumbling the rocket to slow it down before parachutes are opened.

One of the aspects of Ares I that NASA has been praising is the rocket's level of safety. The projected failure rate for an Ares I is about 1 in 2,000, or approximately 20 times safer than the Space Shuttle. Safety is greatly increased by placing the crew above the rocket, as opposed to the shuttle, which is side-mounted to its external propellant tank. The new rocket will incorporate the same type of foam used by the shuttle program today, which became infamous following the destruction of Space Shuttle Columbia in 2003 after it incurred damage from loose foam during liftoff.

The crew mounted on top of Ares I will be safely above falling debris during launch. The crew capsule will also be equipped with an emergency abort system that can lift the crew to safety from the time the rocket is launched until approximately 30 seconds after first stage separation, covering about the first two and a half minutes of flight. The abort system is similar to that of the Saturn V, using a tower equipped with four small motors attached to the top of the crew capsule. In the event of an emergency, the motors are designed to ignite quickly to separate the crew capsule from the rest of the rocket. Parachutes would then be automatically deployed to lower the crew safely to the ground.

In addition to being much safer, Ares I will be more flexible than the shuttle. Besides launching Orion with its crew, the rocket can be launched unmanned with only the service module or other unpressurized cargo. Thanks to its increased practicality and safety, Ares I will be permitted to launch in more dangerous weather conditions than the Space Shuttle. In this respect, launch capability will resemble that of the Russian Soyuz, which has launched in inclement weather including rain, high winds, and fog.

Some design details of the Ares I are bound to change as development continues, though the design described by NASA above shows where the agency currently stands with the Ares I project and presents an idea of how they intend to proceed.

	Metric	U.S.
Dimensions		
Total rocket length	94 m	309 ft
Core SRB diameter	3.7 m	12 ft
Upper stage diameter	5.5 m	18 ft
Weight		
Gross liftoff weight	907,000 kg	2,000,000 lb
Performance		
Payload to LEO	25,000 kg	55,000 lb

Propulsion

Stage 1	(1)	Five-segment shuttle-derived reusable SRB
Stage 2	(1)	J-2X engine

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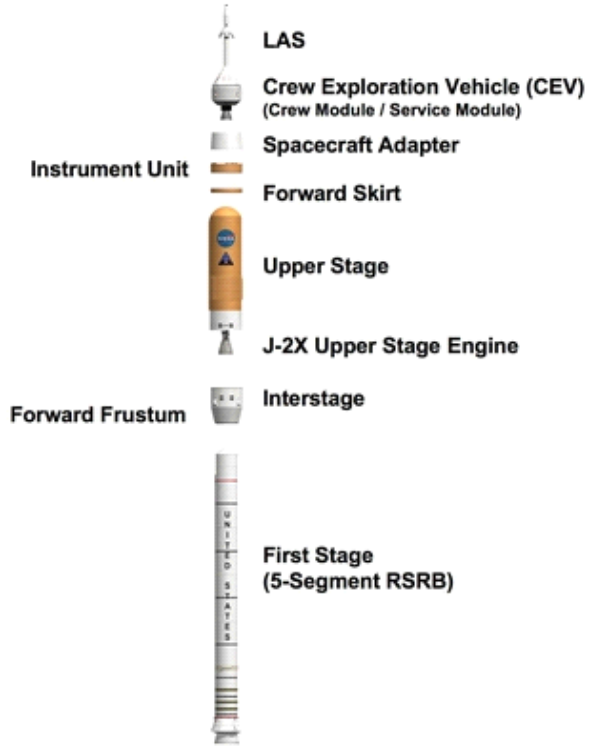
Variants/Upgrades

Ares V. Cargo launch vehicle currently under development. See the "Ares V (Cargo Launch Vehicle)" report in this tab.



The Ares I in an Exploded View

Source: NASA

The Ares I in an Artist's Rendering

Source: NASA

Program Review

Background. NASA began the demanding task of revamping its manned space flight program following the announcement of the Vision for Space Exploration (VSE) by U.S. President George W. Bush in 2004. The VSE outlined short-term and long-term goals for human spaceflight, including the completion of the International Space Station; the return of humans to the Moon for both brief and extended missions; and the eventual voyage of humans to Mars and beyond. Since the Space Shuttle is limited to low-Earth orbit, NASA had to find a way to implement the VSE that would be both affordable and practical. The time frame given was to launch a new manned vehicle in 2011/2012, with a Moon landing between 2018 and 2020.

Following the VSE announcement, NASA launched an Exploration Systems Architecture Study (ESAS) from May 2005 to July 2005. The goals of the study were to:

- assess plans regarding development of a new Crew Exploration Vehicle to replace the Space Shuttle and provide access to the International Space Station
- define requirements and configurations for crew and cargo launch systems for missions to the Moon and Mars
- develop a conceptual exploration architecture for sustained human and robotic lunar operations
- identify key technologies and investment strategies to support and improve such an architecture

NASA Considers Possible VSE Implementations

The finalized ESAS report was published in November 2005, outlining NASA's intended implementation of the VSE. A roadmap was created for the Constellation

Program, consisting of a whole new family of spacecraft and launch vehicles. The Crew Exploration Vehicle (CEV), recently named Orion, would be the central spacecraft in Constellation. Orion would be launched on top of the Crew Launch Vehicle (CLV), renamed Ares I in June 2006, for missions to the International Space Station (ISS) and beyond Earth's orbit. For lunar missions, a Cargo Launch Vehicle (CaLV), designated Ares V in June 2006, would lift a Lunar Surface Access Module (LSAM) and an Earth Departure Stage (EDS) into low-Earth orbit. An Ares I would then lift Orion to dock with the orbiting components to depart for the Moon. Current plans are focusing only on the ISS and lunar missions, though the Ares V would have the ability to launch hardware needed for missions to Mars as well. The study called for the first Ares I flight sometime in 2011.

Design Considerations. A number of designs were considered for the CLV, as shown in the ESAS. One such design was an Evolved Expendable Launch Vehicle (EELV) derived from the heavy-lift variants of the Delta IV and Atlas V rockets. NASA determined that both rockets would require a newly designed upper stage, because the high trajectory of their current Centaur upper stage (see separate report in Tab A) would lead to dangerous deceleration loads on the crew during an abort. The payload capability of the existing upper stages for the Delta IV and Atlas V were also found to be too low by 2,600 kilograms and 5,000 kilograms, respectively. NASA, therefore, believed that an EELV would be too costly and time-consuming to develop as a CLV.

NASA engineers also considered using a core derived from the Space Shuttle External Tank (ET) without SRBs, though this design had limited capabilities. Another design option consisted of a shuttle-derived ET with two side-mounted SRBs. A cargo module would then be side-mounted to the ET, in the same manner as the shuttle. This essentially simplified shuttle configuration, provided limited lift capabilities, and would be difficult to human-rate due to the proximity of the crew to the propellant tank. The design also lacked a practical abort system.

ESAS Suggested Vehicle. The recommended design was an in-line two-stage rocket. The rocket's first stage would be a single shuttle-derived four-segment SRB, with an upper stage powered by a single Space Shuttle Main Engine (SSME) RS-25. A five-segment SRB first stage and twin J-2S second stage design was considered, and preferred by some. That design was set aside because it would not be able to meet the 2011 deadline. The accepted design adhered to the idea of safe, simple, and soon, which is exactly what NASA engineers kept in mind throughout the design process.

Ares Design Loses Some Shuttle Components

Both Ares I and Ares V designs underwent significant changes in 2006. Because of budget changes, the goal for the first flight was pushed back to at least 2012. The delay meant the team would have the time to develop a five-segment SRB first stage, which was the preferred ption due to its increased performance over a four-segment SRB. The upper stage engine was switched as well, as the $80 million SSME would require more costly development just to make it worthwhile on a disposable rocket. The J-2X, a modified version of the J-2S used on the Saturn V, was chosen as the new upper stage engine. The same engine would be used on the Ares V upper stage as well.

Engine Testing. In May 2006, NASA's Marshall Space Flight Center began a series of hot-fire tests on a subscale model of the J-2X. The tests are aimed at investigating ways to increase the performance of the upper stage engine. Pratt & Whitney, the developer of the engine, is forming a new program office that will be in charge of development and testing of the J-2X. Pratt & Whitney worked on a $50 million J-2X development contract that ran through November 2006.

GAO Doubts NASA Strategy. A report from the Government Accountability Office, published in July 2006, expressed concern over the Constellation Program, particularly in regard to the acquisition strategy of the Orion spacecraft. The GAO felt that NASA did not have a sound business strategy in place, and that the project would be subject to cost overruns, delays, and poor performance results. They suggested NASA delay awarding the Orion contract, which was supposed to take place in September 2006, to allow more time for design study. NASA disagreed with the GAO findings and proceeded to award the Orion contract to Lockheed Martin in August 2006. A delay in the Orion contract would have impacted Ares I, as well as the rest of the Constellation Program development. NASA hoped to move ahead quickly with both Orion and the Ares I to see a launch as close to the retirement of the Space Shuttle as possible.

NASA Tests Orion/Ares I Parachutes

In August 2006, engineers completed a series of drop tests on the parachute systems that will be used for Orion and the Ares I first stage booster. The Ares I tests collected data on the pilot parachute, the first of a three-stage rocket recovery system.

Upper Stage Engine Contract Awarded

In 2007, Pratt & Whitney Rocketdyne was awarded a NASA contract valued at $1.2 billion to design, develop, and test a J-2X engine that will power the

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upper stages of the Ares I and Ares V launch vehicles. The J-2X is powered by liquid oxygen and liquid hydrogen, and will provide 294,000 pounds of thrust to power the Ares vehicles. The contract award includes ground and test flight engines and extends through December 31, 2012.

ATK Picks Up More LAS Work

In 2007, Alliant Techsystems received a $62.5 million contract from Orbital Sciences Corporation for the main abort motor of the NASA Orion crew exploration vehicle Launch Abort System (LAS). Under the terms of the contract, ATK will design, develop, produce, test, and deliver the launch abort motor (LAM), the largest of three propulsion units integrated into the LAS. The contract includes four full-scale static test units and eight deliverable motors to Orbital for pathfinders, test flights, and program support. Orbital is subcontracted to Lockheed Martin, the prime contractor for Orion.

Alcoa Tapped for Ares I Materials

In 2007, NASA awarded Alcoa's North American Rolled Products business a one-year contract to develop the manufacturing capability and supply of high performance aluminum-lithium plate and ingot to be used for the Ares I crew launch vehicle (CLV) upper stage. The material will be sourced from Alcoa's Davenport Works in Iowa and the Alcoa Technical Center near Pittsburgh, Pennsylvania. The value of the contract was not disclosed.

Roll Control System Contract Awarded

In 2007, NASA selected Aerojet-General Corp of Redmond, Washington, to provide developmental engines for the Ares I crew launch vehicle first stage roll-control system. The engines are the first in a series of steps to develop the roll-control system to manage the amount of rotation by the first stage solid rocket from liftoff to its separation from the second stage, ensuring that Ares I stays on the designated trajectory for the first two minutes of flight. The cost-plus-fixed-fee competitively awarded contract has an 11-month period of performance and a potential total value of $8.1 million if the additional 11-month contract option for engine fabrication and testing is exercised.

NASA Completes Review Milestone

In 2007, NASA completed the Ares I crew launch vehicle system requirements review – the first such milestone for a U.S. human-rated launch vehicle system in more than 30 years. The review confirmed that the Ares I system requirements were complete, validated, and responsive to mission requirements. It also confirmed that the Ares I architecture and design concept can fulfill the mission objectives and that the Ares project is ready to begin engineering design activities.

NASA Extends Ares I Development Contract

In 2007, NASA authorized a $48 million contract action with ATK Launch Systems of Brigham City, Utah, to continue design and development of the first stage for the Ares I crew launch vehicle. This Ares I first stage contract action will increase a first stage task under an existing shuttle contract by $48 million for a total work effort valued at $111 million. The contract action maintains the design, development, test, and evaluation schedule; expedites the procurement of new nozzle metal hardware and production tooling for propellant casting and nozzle fabrication; maintains the necessary design and engineering analysis; and continues participation in pilot parachute development tests. The action also provided support for an initial test flight in the third quarter of 2009, known as Ares I-X. The test flight will use a simulated fifth segment on the first stage and a simulated upper stage.

Shakes Not a Problem

Concerns that the new Ares I rocket could suffer from severe vibrations have eased after new analyses have found that the problem is not as severe as once thought. NASA officials said in April 2008 that the thrust oscillation problem with the Ares I was not strong enough to pose a risk to crews on the Orion spacecraft, which would be launched by the Ares I. Engineers are also looking into solutions to mitigate the vibrations, including shock absorbers on the rocket or dampers under the seats inside Orion. The Ares I lower stage is a five-segment version of the solid rocket boosters used on the Space Shuttle; many solid-fuel boosters suffer from thrust oscillation problems.

First Test Flight in 2009

The first test flight of Ares I, designated Ares I-X, took place in October 2009. Another test (Ares I-Y) is tentatively scheduled for August 2014. However, NASA has proposed canceling the test of the Ares I-Y because of lack of funding. The test rocket launched from Launch Pad 39B, and was transported to the pad using the shuttle crawler-transporter. The five-segment SRB was not ready in time, so the test rocket used a four-segment booster with an inert dummy fifth segment. The first stage used motors that were readied for – but not flown on – Space Shuttle Discovery mission STS 114. The upper stage was instrumented but inert and housed a mock-Orion spacecraft, as well as additional weights to simulate propellant.

The tests focused on stage separation, atmospheric entry dynamics, parachute performance, first stage thrust and

roll control, and assembly and vehicle recovery after the launch. The first stage burned for approximately 130 seconds, reaching a suborbital height while traveling at Mach 4. Like the shuttle SRBs, the test stage burned a star-shaped mix of polybutadiene acrylonitrile. Engineers are still working on final propellant mix and nozzle design.

Funding

Funding for the Ares I (CLV) Project falls under the Constellation Systems Program, which is located in the Constellation Systems Theme. The Constellation Systems Theme is part of the Exploration Systems Mission Directorate.

Beginning in FY11, there is no funding line for Ares I (Crew Launch Vehicle). According to NASA's FY11 budget request, funding in the Constellation Program provides for transition and closeout activities. NASA has allocated $2.5 billion between FY11 and FY12 for Constellation Transition costs.

Timetable

Month	Year	Major Development
Jan	2004	President George W. Bush announces VSE
Nov	2005	ESAS final report published outlining initial launch vehicle goals
Jan	2007	System Requirements Review
Apr	2008	Preliminary Design Review
Oct	2009	Ares I-X test flight
Feb	2010	FY11 NASA budget proposes Constellation termination

Forecast Rationale

With the release of NASA's FY11 budget request in February 2010, it became clear that NASA wants to cut the Constellation program, and with it all of the components that make it up, including the Ares I rocket. Despite a successful launch of the Ares I-X in October 2009, NASA is going to follow a new path to meet its space exploration goals.

Based on a 2005 analysis by the Congressional Research Service (CRS), the cost of developing and flying the new Crew Exploration Vehicle (CEV) to the Moon would total $24 billion. A companion craft that could set down on the Moon by 2020 would cost an additional $40 billion. The figures include the cost of developing rocket boosters to launch both. NASA has already spent an estimated $9 billion on development of the Constellation.

In 2009, the Review of U.S. Human Spaceflight Plans Committee released its final report. The report said that plans at the time were unsustainable at then-current funding levels. In addition, the committee estimated that delays in the Orion program will mean the CEV will not be ready to transport humans to the space station until after 2015, the planned final year of operation for the station.

Budget constraints, along with the findings of the Human Spaceflight Committee, forced NASA to reconsider the Constellation program, and with it, the Ares I. Instead of the ambitious project, NASA wants to award contracts to private companies to taxi astronauts to and from low earth orbit and to the International Space Station. These capsules will not rely on dedicated launch vehicles designed by NASA solely for government work, but instead will utilize commercially developed launch vehicles.

This plan has met with strong resistance from many members of Congress, who are opposed to giving up an "in-house" manned space program. They cite the loss of jobs and U.S. international leadership in space activities as major reasons to maintain the Constellation program. The White House has promised its opponents that NASA will begin development of a new heavy-lift launch vehicle by 2015, minimizing as much as possible the amount of time the U.S. will go without a government-owned human transport capability.

While the outcome of the debate over NASA's budget is still to be determined, the outlook for the Ares I is not promising. NASA and the White House are strongly committed to handing human transport duties to low

Ares I (Crew Launch Vehicle)

Earth orbit over to commercial operators. At the same time, the agency will begin studying technologies that could be used for future heavy-lift launch vehicles that will be able to transport humans far-off locations, such as the Moon, Mars, or near-Earth asteroids. Forecast International does not expect any Ares I launch vehicles to be produced during the 10-year forecast period.

Ten-Year Outlook

No Ares I launch vehicles forecasted to be produced over next 10 years.

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