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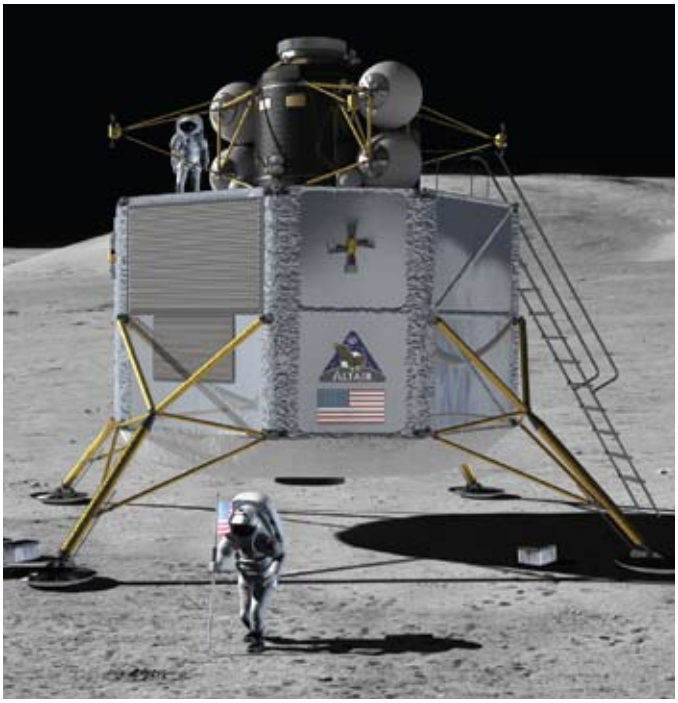
Constellation Program:

America's Spacecraft for a New Generation of Explorers

The Altair Lunar Lander



Overview

The Altair lunar lander is a key component in NASA's Constellation Program, a combination of spacecraft, launch vehicles and missions that will return human explorers to the moon and ultimately will allow them to explore other destinations in the solar system. The Altair lunar lander will deliver crews and lunar surface system hardware to the moon by 2020, and its first test flight is scheduled for 2019. Altair is named for the brightest star in the constellation Aquila (the Eagle), a tribute to the first Apollo lunar module that carried explorers Neil Armstrong and Buzz Aldrin to the moon in 1969. The word Altair originates from an Arabic term meaning "the flying one," and it joins Orion and Ares as the vehicles of the Constellation program.

Altair is a multi-role vehicle capable of landing crews of four astronauts anywhere on the lunar surface and supporting them for missions of up to seven days before returning them to orbit. In addition, Altair can deliver crew members to a lunar outpost facility and remain with them for up to six months, including delivery of up to 17 metric tons of cargo to support the buildup of the lunar outpost itself. Each vehicle uses a common descent stage, with combinations of an ascent stage, an airlock and cargo added for specific missions.

The Mission

To accomplish its mission, Altair and its Earth departure stage will be launched into a low-Earth orbit using an Ares V launch vehicle, followed by a separate launch of an Orion spacecraft lifted by an Ares I launch vehicle. Once Altair and Orion rendezvous and dock in Earth orbit, the Earth departure stage ignites its engines to place the crew on a trans-lunar trajectory. After discarding the Earth departure stage, Altair takes over the duty of flying itself and Orion on the correct trajectory to the moon. Following a three-day coast, Altair's descent engine is fired to bring the Orion-Altair stack into low lunar orbit. The crew then transfers into the lander, undocks from Orion and begins its decent to the lunar surface. The Orion vehicle remains unoccupied and parked in lunar orbit. The Altair descent propulsion system completes the 2.5-hour descent to the surface with a soft landing. The crew then transitions the vehicle for surface operations.

In the sortie mode, Altair can place the crew of four astronauts and up to 500 kg (1,100 pounds) of science equipment anywhere on the lunar surface and provide living quarters for the crew for up to seven days. Altair features an airlock to allow the crew to transition from its pressurized habitat to the dusty vacuum of the lunar surface. In outpost mode, Altair can deliver the four crew members to the site of a permanent lunar outpost, where it can loiter on the surface for up to 210 days, waiting to return the crew to lunar orbit at the end of their outpost stay. At the conclusion of the surface mission, the crew boards the Ascent Module

with their collected science samples and begins a 2.5 hour ascent to the Orion module waiting for them in lunar orbit. The crew docks with Orion, transfers to Orion and disposes the ascent module. Orion's service module engine ignites to place the crew on a trajectory towards home, and after a three-day journey toward Earth, the mission concludes with the Orion spacecraft parachuting back to the Earth's surface.

The Altair lander also can be used to transport large cargo elements to the lunar surface. In cargo mode, the descent module is configured to autonomously land at a preselected site with up to 14,500 kg (31,900 pounds) of science equipment, lunar rovers, habitat modules, power systems, resource utilization equipment and outpost logistics. The ability to land large cargo elements is critical to the deployment of the lunar outpost.

Best of the past, best of the future

NASA has maintained a core capability for lunar vehicle design since the conclusion of the Apollo missions. Apollo veterans are now assisting the next generation of engineers in the design of this next generation lunar lander. Since 2005, more than 100 lunar lander concepts have been studied, with the best features captured in the current Altair design. The present lunar lander bears some similarities to the Apollo lunar module, a result of the physics of spaceflight reflected in the design of the vehicle. Like Apollo, Altair is a two stage vehicle. The large descent module is a large propulsion stage consisting primarily of propellant tanks, a main engine, landing gear and supporting structure. The small ascent module contains the pressurized crew cabin, life support systems, docking systems, avionics, and the propellant and engine required for lunar ascent.

But where the physics of spaceflight has remained unchanged, technology has matured and Altair's missions are well beyond what the Apollo system was capable of performing. Altair will feature current technology advances in advanced computers, guidance and navigation systems, composite structures, precision landing ability and high efficiency propulsion systems. Additionally, each Altair lander will double the crew size of Apollo's lunar module, and more than double the sortie mission time spent on the lunar surface. Altair will also provide an airlock to allow split crew operations and to control lunar dust.

After discarding the Earth departure stage, Altair takes over the duty of flying itself and Orion on the correct trajectory to the moon.

The Altair Team

The Altair lunar lander project office, which is located at NASA Johnson Space Center, comprises experts that are recruited from every NASA center and includes Apollo Program veterans on its consultant team. An innovative, risk-informed design process is being used that allows the team to design a vehicle with the best safety and reliability characteristics possible. As the program progresses, the Altair team will consist of industry partners that will be active in all aspects of the Altair design.

By the Numbers

	Apollo Lunar Module	**Altair** Lunar Lander
Crew Size (max)	2	4
Surface Duration (max)	3 days	7 days (Sortie missions), Up to 210 days (Outpost missions)
Landing site capability	Near side, equatorial	Global
Stages	2	2
Overall height	7.04 m (23.1 ft.)	9.75 m (32.0 ft.)
Width at tanks	4.22 m (13.8 ft.)	8.8 m (28.9 ft.)
Width at footpad centers (diag.)	9.45 m (31 ft.)	13.5 m (44.3 ft.)
Crew module pressurized volume	6.65 m^3 (235 cu. ft.)	17.5 m^3 (618 cu. ft.) – crew module + airlock
Ascent Stage mass	4,805 kg (10,571 lbs.)	6141 kg (13,510 lbs.)
Ascent Stage engines	1 – UDMH-NTO	1 – MMH-NTO
Ascent engine thrust	15.6 kN (3,500 lbf.)	24.5 kN (5,500 lbf.)
Descent Stage mass	11,666 kg (25,665 lbs.)	37,045 kg (81,500 lbs.)
Descent Stage engines	1 – UDMH-NTO	1 – pump-fed, throttling, LOX/LH2
Descent engine thrust	44.1 kN (9,900 lbf.)	83.0 kN (18,650 lbf.)

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