NASA Crew Launch Vehicle Overview

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The U.S. Vision for Space Exploration, announced January 2004, outlines the National Aeronautics and Space Administration's (NASA) strategic goals and objectives. These include:

- Flying the Shuttle as safely as possible until its retirement, not later than 2010.
- Bringing a new Crew Exploration Vehicle (CEV) into service as soon as possible after Shuttle retirement.
- Developing a balanced overall program of science, exploration, and aeronautics at NASA, consistent with the redirection of the human spaceflight program to focus on exploration.
- Completing the International Space Station (ISS) in a manner consistent with international partner commitments and the needs of human exploration.
- Encouraging the pursuit of appropriate partnerships with the emerging commercial space sector.
- Establishing a lunar return program having the maximum possible utility for later missions to Mars and other destinations.

Following the confirmation of the new NASA Administrator in April 2005, the Agency commissioned a team of aerospace subject matter experts from government and industry to perform the Exploration Systems Architecture Study (ESAS), which provided in-depth information for selecting the follow-on launch vehicle designs to enable these goals. The ESAS team analyzed a number of potential launch systems, with a focus on: (1) a human-rated launch vehicle for crew transport and (2) a heavy lift launch vehicle (HLLV) to carry cargo.

After several months of intense study utilizing technical performance, budget, and schedule objectives, the results showed that the optimum architecture to meet the challenge of safe, reliable crew transport is a two-stage variant of the Space Shuttle propulsion system — utilizing the reusable Solid Rocket Booster (SRB) as the first stage, along with a new upper stage that uses a derivative of the RS-25 Space Shuttle Main Engine to deliver 25 metric tons to low-Earth orbit. The CEV that this new Crew Launch Vehicle (CLV) lofts into space early next decade will initially ferry astronauts to the Space Station and be capable of carrying crews back to lunar orbit and of supporting missions to Mars orbit (see Figure 1). The HLLV system will utilize the Shuttle External Tank combined with SRBs. The focus of this paper is on the CLV system, giving an overview of plans and progress to date.

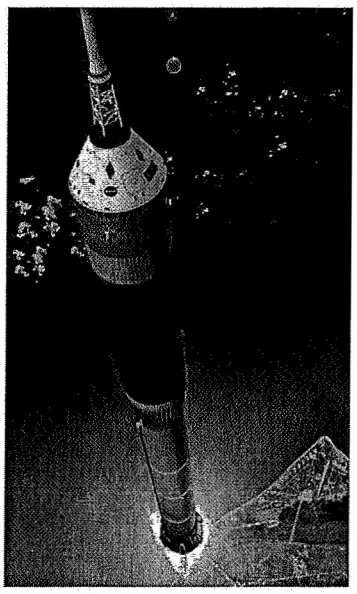

Figure 1. NASA plans to launch the Crew Exploration Vehicle on the Crew Launch Vehicle early next decade (artist's concept).

The CLV Project, managed by the Exploration Launch Office located at NASA's Marshall Space Flight Center, was established in September 2005 to design, develop, test, evaluate, and operate the new human-rated launch system. Working closely with NASA's Constellation Program, the ultimate goal of the CLV Project is to deliver a safe, reliable system designed to minimize lifecycle costs so that NASA's budget can be more fully invested in missions of scientific discovery.

The CLV architecture selected (see figures 2 and 3) is a single four-segment SRB with a new upper stage supporting the liquid oxygen/liquid hydrogen (LOX/LH2) RS-25 engine, which will be modified for altitude-start capability. Analysis, modeling, and simulation showed that this launch vehicle option, though not without risk, could best meet technical, schedule, and budget parameters, given existing Shuttle hardware inventories; extensive manufacturing, processing, and operational infrastructure; and specialized workforce capabilities. The CLV Project works closely with the Shuttle Program in this regard and to leverage the wealth of lessons learned during the Shuttle era.

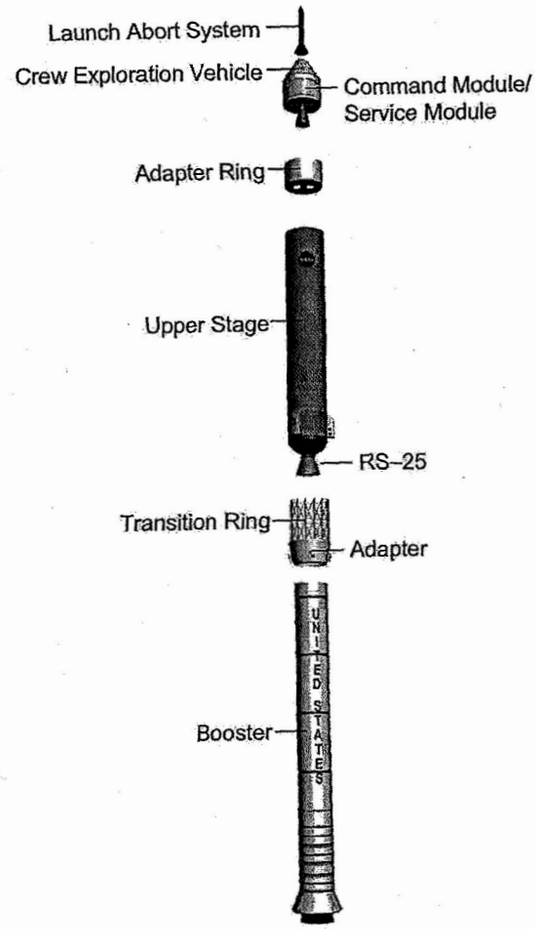

Figure 2. The Crew Launch Vehicle system concept.

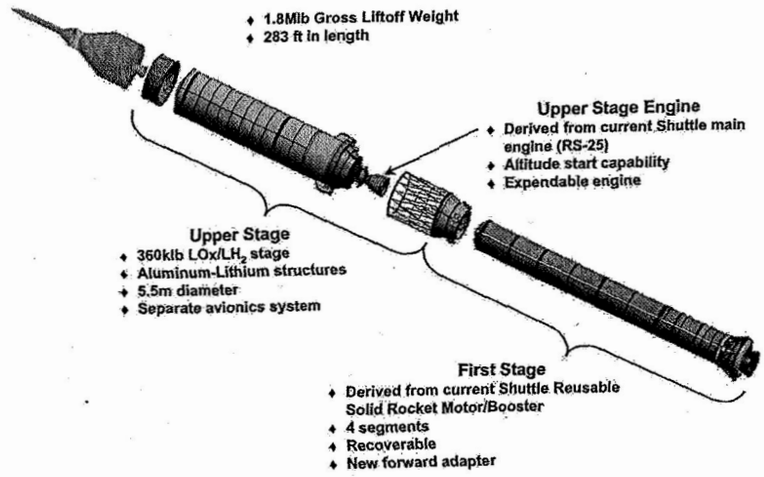

Figure 3. The Crew Launch Vehicle will utilize Shuttle propulsion elements, along with a new upper stage.

The CLV design approach is based on validating requirements and conducting rigorous systems engineering trades studies against the concept design, leading to a System Requirements Review (SRR), scheduled for June 2006. The SRR, the first major milestone in CLV development, assures that CLV requirements are properly defined and implemented, are traceable, and that the hardware and software will be built to the authorized baseline configuration requirements. The SRR confirms that the total CLV system and the individual first stage, upper stage, and upper stage engine elements' design and interface requirements are defined before proceeding to the design phase and its associated Preliminary Design Review (PDR).

Completed design specifications will be provided at the PDR, planned for April 2008. The Critical Design Review, projected for August 2009, will verify that the CLV system design meets requirements, establish quality assurance plans, and baseline the "build to" specifications. The Design Certification Review, projected for March 2012, is the control gate that ensures the CLV system can accomplish its mission goals. In addition to these documentation data reviews, the CLV path to flight includes verification flight-testing as early as 2010, leading to the first flight of a crew to the Space Station in the 2012 timeframe.

The CLV system is a foundational piece of America's future in space and is the first step in executing the Agency's strategic plan for lunar exploration in 2018. Lessons learned from developing the CLV will be applied to the growth path for future systems, including the HLLV, as the Nation continues its journey of discovery to the Moon, Mars, and beyond.