NASAfacts

Space Launch System RS-25 Core Stage Engine

Powering America's Exploration of Deep Space: The Engines Behind NASA's Space Launch System

NASA's Space Launch System (SLS), the most powerful rocket in the world, will be powered by RS-25 engines that combine proven performance with advanced engineering and technology. The SLS will launch astronauts on missions to the Moon and eventually to Mars.

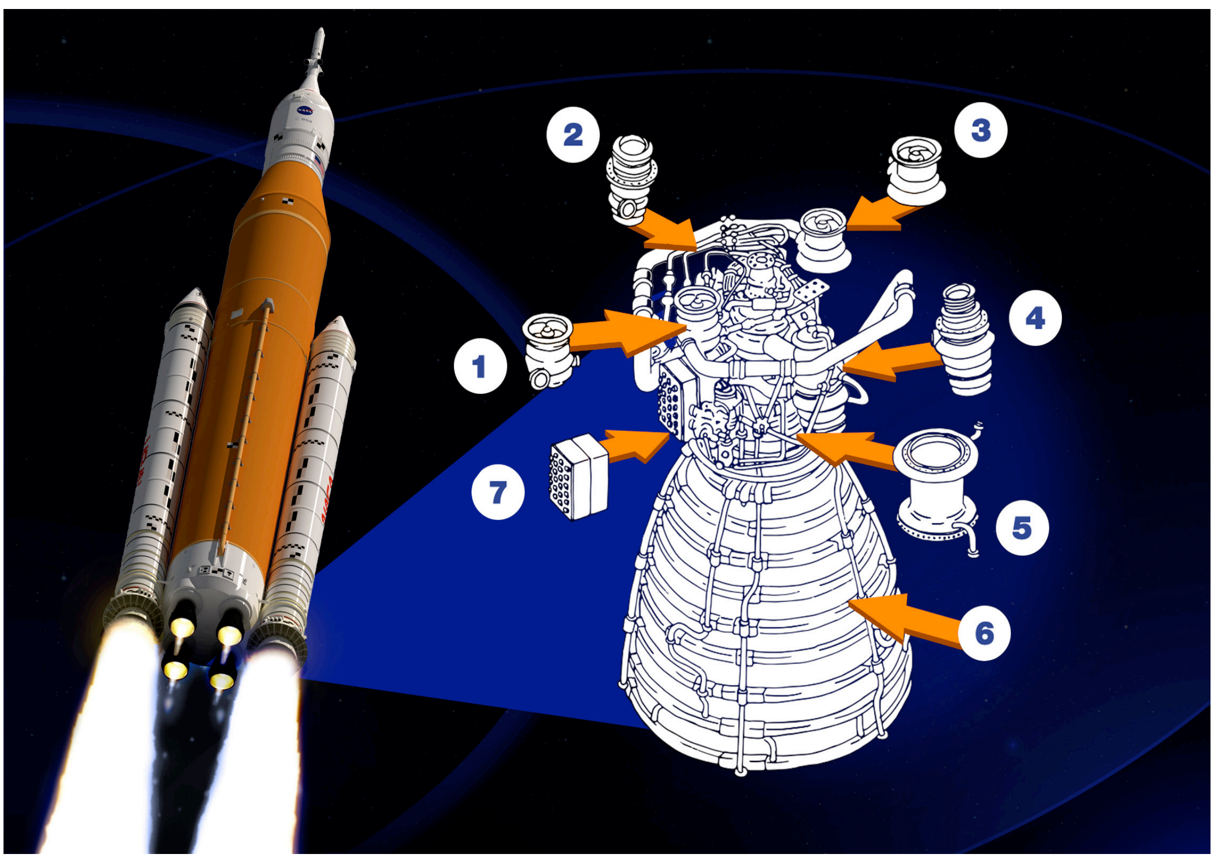
The SLS Program is taking advantage of hardware and cutting-edge manufacturing techniques developed for the Space Shuttle Program and other exploration programs. These are being integrated with new designs and new technologies, significantly reducing development and operations costs. SLS is designed to be flexible and evolvable, to meet a variety of crew and cargo mission needs.

The first SLS variant to fly, the Block 1, will be able to carry 27 t (59,525 pounds) to the Moon. It will use four RS-25 engines for the core stage, along with two solid rocket boosters.

RS-25 Core Stage Engine Evolution

The RS-25 powered the space shuttle for over three decades and completed 135 missions. It is one of the most tested large rocket engines in history, with more than 3,000 starts and more than 1 million seconds of total ground test and flight firing time.

During the Space Shuttle Program, the RS-25 underwent several design updates to improve service life, durability, reliability, safety, and performance. SLS takes advantage of that technology investment and experience.



RS-25 engine callouts: 1-4 - Turbo Pumps, 5 - Main Combustion Chamber, 6 - Nozzle, 7 - Engine Controller

The SLS Program has an inventory of 16 RS-25 flight engines, built by Aerojet Rocketdyne of El Segundo, California, transferred from the Shuttle Program.

Two additional RS-25 ground test engines are being used at NASA's Stennis Space Center to test fire updates to the engine, adapt it to SLS performance requirements and operating environments, certify new controllers, and support development of future engine components.

The RS-25 rocket engine test era for SLS began Jan. 9, 2015, with a 500-second – more than 8 minutes – hot fire of RS-25 developmental engine No. 0525 on the A-1 Test Stand at Stennis.

NASA tested the first SLS flight engine on March 10, 2016. Altogether, the agency has conducted 32 developmental and flight engine tests for a total of 14,754 seconds – more than four hours of cumulative hot fire – all on the A-1 stand at Stennis.

During the Shuttle Program, the RS-25s routinely operated in flight at 104.5% of their original 100% rated thrust level but were tested up to 111% thrust. To meet the demands of SLS flight, more power and performance would be required.

Between March 2017 and April 2019, the engine test series at Stennis certified the engines to operate at normal SLS flight levels of 109%. During such tests, new and more capable engine controllers were tested for every engine. In the process, the engine was tested at thrust levels up to 113% to allow for operating safety margins.

To date, two SLS flight sets of four engines each have been adapted for their new Artemis missions and processed for flight, and a third flight set is undergoing processing. All the controllers have been tested as well. In addition to new controllers, each engine received additional insulation to protect it from the hotter launch environment of being closer to the twin solid rocket boosters.

The next planned evolution of the SLS, Block 1B, would use a more powerful Exploration Upper Stage (EUS) to enable more ambitious missions, and a 38 t (83,776 lbs.) lift capacity to the Moon.

RS-25 rocket engine hot fire test at NASA's Stennis Space Center

RS-25 Engine Facts

Thrust	512,300 lbs. (vacuum) 416,300 lbs. (sea level)
Size	4.2m x 2.4m (14 ft x 8 ft)
Weight	3.49 t (7,800 lbs.)
Operational Thrust	109 percent
Operational Time	approximately 8 minutes
Operational Temp Range	-423 to +6000 degrees F

A later evolution, Block 2, will use advanced solid or liquid propellant boosters, to provide up to 46 t (101,400 lbs.) lift capacity to deep space. In each configuration, SLS will continue to use the same core stage design and four RS-25 engines.

The liquid hydrogen/liquid oxygen-fueled engines are compact and high performance. At full throttle, each of the four engines will produce 512,300 pounds of vacuum thrust, generating 10 times the equivalent thrust-to-weight power density of the largest commercial jet engine.

During liftoff, the Block 1 configuration of SLS will produce 8.8 million pounds of thrust — 15 percent more than the Saturn V rockets that launched astronauts on journeys to the Moon.

NASA has contracted with Aerojet Rocketdyne to restart production of a more affordable variant of the RS-25 tested and certified for flight at a higher thrust level. This new engine will use a simplified design, new manufacturing technologies, new inspection technologies, and processes that reduce handling and support labor, hardware defects, and production time.

One of the most promising technologies is selective laser melting (SLM). This technology uses a high-energy laser and metal powder to produce parts more quickly and at lower cost than is possible with conventional manufacturing methods. Because they are made of fewer separate parts, these SLM parts are more structurally sound, resulting in a safer vehicle.

For more information about SLS, visit:

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National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Huntsville, AL 35812
www.nasa.gov/marshall

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