RS-25: The Clark Kent of Engines for the Space Launch System

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In the iconic comic-book series, "Superman," the main character, Clark Kent, looks like your average Joe. Under the ruse of a three-piece suit and glasses, Kent's true identity is "Superman," who transforms into his mighty persona to do battle for the good of humankind. In the rocket engine world, the RS-25 is Clark Kent.

Four RS-25 engines, like the one pictured above undergoing a hot-fire test, power the core stage of NASA's Space Launch System (SLS)—NASA's heavy-lift launch vehicle.

Image credit: Aerojet Rocketdyne, NASA

Four RS-25 engines will power the core stage of NASA's Space Launch System (SLS)—NASA's new heavy-lift launch vehicle. Towering more than 200 feet tall with a diameter of 27.6 feet, the core stage stores cryogenic liquid hydrogen and liquid oxygen that feeds the vehicle's RS-25 engines.

SLS will be the most powerful rocket in the world with the greatest capacity of any launch system ever built to support any destination, any payload and any mission, including NASA's plans to send humans to a captured and relocated asteroid. The 70-metric-ton (77-ton) configuration will stand at 321 feet, which is taller than the Statue of Liberty.

The RS-25, also known as the space shuttle main engine, is the first reusable rocket engine in history.

"During the 30-year run of the Space Shuttle Program, the RS-25 achieved very high demonstrated reliability," said Garry Lyles, chief engineer for the Space Launch System Program Office at NASA's Marshall Space Flight Center in Huntsville, AL, which manages the SLS Program for the agency. "And during 135 missions and numerous related engine tests, it accumulated over 1 million seconds—or almost 280 hours—of hot-fire experience. With that kind of reliability, we knew it would be the best engine to power SLS."

The RS-25s may look like that Clark-Kent-average-Joe persona from the outside, but when ignited, the engines reveal their "Superman" identity—pushing the SLS 73 times faster than an Indianapolis 500 race car.

And if that doesn't seem superhero enough:

- The fuel turbine on the RS-25's high-pressure fuel turbopump is so powerful that if it were spinning an electrical generator instead of a pump, it could power 11 locomotives; 1,315 Toyota Prius cars; 1,231,519 iPads; lighting for 430 Major League baseball stadiums; or 9,844 miles of residential street lights—that's all the street lights in Chicago, Los Angeles or New York City.
- Pressure within the RS-25 is equivalent to the pressure a submarine experiences three miles beneath the ocean.
- The four RS-25 engines on the SLS launch vehicle gobble propellant at the rate of 1,500 gallons per second. That's enough to drain an average family-sized swimming pool in 60 seconds.

"The RS-25 is very high-performance, proven reliable and can take the SLS from the ground all the way to orbit," said Mike Kynard, SLS Liquid Engines program manager at the Marshall Center. "There's only one engine in the U.S. with enough thrust combined with high performance like that, and it's the RS-25."

Modifications were needed on the heritage engines to prepare them for the new heavy-lift vehicle. "We need more thrust on the SLS than the shuttle, since we have a heavier payload," Kynard said. "The core stage is a good bit larger than the external tank on the shuttle. To accommodate the higher thrust level, we increased the number of engines we had from three to four, and increased the power level of each engine."

Engines on the shuttle ran at 491,000 pounds vacuum thrust (104.5% of rated power level). After analyzing temperature and other factors on the engine, the power level was increased for SLS to 512,000 pounds vacuum thrust (109% of rated power level).

A total of 16 RS-25 flight engines are stored at NASA's Stennis Space Center near Bay St. Louis, MS, until testing begins in 2014 on its A-1 test stand. The A-1 stand is currently undergoing modifications to accommodate the RS-25 engine and the new SLS conditions. In the space shuttle era, the engines were tested at Stennis for more than three decades.

"Anytime we make changes to an engine, or to environmental conditions in which it will run, we'll need to put it through its paces," Kynard said. "What we typically do in rocket engine testing is run things twice as long as we plan to use them for flight. We run it at different conditions to make sure we've covered the full range of the planned operation."

The RS-25s will have a chance to flex their muscles on the first flight test of the SLS, scheduled for 2017. The flight will feature a configuration for a 70-metric-ton (77-ton) lift capacity and carry an uncrewed Orion spacecraft beyond low-Earth orbit to test the performance of the integrated system. As the SLS evolves, it will provide an unprecedented lift capability of 130 metric tons (143 tons) to enable missions even farther into our solar system to places like Mars.

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For information about NASA's SLS Program, visit: http://www.nasa.gov/sls/.

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