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SHAPING THE FUTURE OF AEROSPACE

New engine development on the rise, with liquid methane taking center stage

BY BRANDIE L. RHODES

The **Liquid Propulsion Technical Committee** works to advance reaction propulsion engines employing liquid or gaseous propellants.

▲The final Ariane 5 was launched in July from Kourou, French Guiana, carrying two communications satellites. Its successor, the Ariane 6, is targeted to make its inaugural flight in 2024.

ESA/CNES/Arianespace/Optique video du CSG/P. Piron

In July, an **Ariane 5** lifted off from the **Kourou Spaceport** in French Guiana for the 117th and final time. The expendable design was the guarantor of Europe's independent access to space for almost three decades. In preparation for the inaugural flight of an **Ariane 6**, scheduled for 2024, **ArianeGroup** fired the **Vulcain 2.1** engine at the Kourou launch complex. Also in September, engineers from the **German Aerospace Center, or DLR**, the **European Space Agency** and **ArianeGroup** completed hot fire testing of the Ariane upper stage, which includes the **Vinci** engine and an auxiliary power unit, at the DLR site in Lampoldshausen, Germany.

SpaceX's second fully stacked **Starship-Super Heavy** took to the skies in November. The flight ended early, but SpaceX achieved several objectives, including ignition of all engines and clearing the launch pad, plus booster and upper stage separation via a new **hot-staging technique,** in which the upper stage engines ignited while still connected to the booster. The Starship upper stage is powered by three gimballing, sea-level optimized engines and three fixed-vacuum-optimized full-flow staged-combustion-cycle engines, each powered by **liquid oxygen and liquid methane**.

In March, NASA selected **Blue Origin's National Team** to provide the second human landing system for the Artemis program. The lander, which will carry astronauts for the **Artemis V** mission scheduled for 2029, will be powered by the **BE-7**, a deep throttling **liquid oxygen/liquid hydrogen engine**. Starting with Artemis V, NASA's **Space Launch System** rockets will be powered by redesigned **Aerojet Rocketdyne RS-25** engines. The updated engines will have simplified component designs that take advantage of 3D printing and other manufacturing advances. In June, a series of certifications tests were completed at **NASA's Stennis Space Center** in Mississippi, in which an RS-25 was powered for eight minutes to represent how long the engines must operate during flight.

In June, **United Launch Alliance** test fired a **Vulcan Centaur** booster with two **Blue Origin BE-4** engines. Vulcan's inaugural flight, scheduled for December, will also be the first flight of these liquid oxygen and liquid methane engines.

In July, **Sierra Space** of Colorado won an **U.S. Air Force contract** of $22.6 million to continue the maturation of its **VR35K-A** advanced upper stage engine. The VR35K-A is a liquid oxygen/liquid hydrogen staged combustion cycle engine that produces 140 kilonewtons of thrust. The engine has a single-shaft turbo-pump assembly for simplified operation and mechanically coupled mixture ratio control.

In February, **Dynetics** of Alabama completed a full-scale combustion chamber test of its 35-kilonewton **dual expander main engine** at **NASA's Marshall Space Flight Center** in Alabama and vacuum testing of its **dual mode reaction control system thrusters.** Dynetics further matured the technologies this year under a NASA Human Landing Systems Next Space Technologies for Exploration Partnerships-2 Appendix N contract.

German startup and launch service provider **Rocket Factory Augsburg** completed a full-duration hot-fire test of its **Helix** engine in June. This was the first time that a privately developed staged combustion upper stage had been successfully hot fired in Europe. **The Exploration Co.**, another German space startup, tested its reusable and throttleable orbital bio-methane and oxygen full-scale thrust chamber on the **P8** test bench in Lampoldshausen in July.

Liquid oxygen/liquid methane engine development also progressed in Italy and France. **ArianeGroup** completed the first test of the **Prometheus** engine in June, with a 12-second burn while integrated to the **Themis** first-stage demonstrator. **Avio** of Italy completed the first test of the **M10/DM2** engine in August at the new **Space Propulsion Test Facility** in Sardinia. Also, in March, the Italian government awarded a 103.7-million-euro contract to Avio, initiating the development of an additional engine called HTE. ★

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