National Aeronautics and Space Administration

Solid Propulsion Technology and Development

Proven Technology for a New Era of Applications

A new generation of technologies is expanding solid propulsion capabilities and increasing their relevance for nanolaunch, in-space, and destination capabilities. Solid propulsion systems continue to be a reliable way to provide thrust and are used in almost every Earth-to-orbit launch capability. Marshall's solid propulsion team has decades of comprehensive experience with solids from nanoscale to heavy-lift applications.

The Center has built a collaborative, scalable, and reliable capability to work with NASA, DOD, and industry to solve future solid propulsion problems.

Marshall continues to mature solid propulsion technologies, including some with breakthrough potential. While supporting ongoing solid propulsion applications for the Space Launch System (SLS) and Orion, Marshall is actively engaged in new development efforts including nanolaunch, low-cost sounding rockets, extinguishable/restartable propellants, and sample return/ascent technologies. Marshall helps lead the way in developing solutions and advancing solid propulsion technologies.

At-A-Glance

Solid propellants are a highly reliable method for delivering thrust and have a wide range of future applicability. Marshall Space Flight Center has comprehensive expertise and extensive experience with solid propulsion for nanoscale to heavy-lift applications. The Center has built a collaborative, customizable, and reliable development capability to work with the solid propulsion community, both to provide design solutions and to mature technology.

Marshall tested a small solid rocket motor designed to mimic NASA's SLS booster. The test provided an effective way to evaluate a new nozzle insulation material.

Peregrine — A Solid Solution for Next Generation Sounding Rockets

The Marshall solid propulsion team is demonstrating successful development capabilities, collaboration, and customization expertise with the Peregrine motor development project — a joint project among Marshall, Goddard/Wallops Flight Facility, and industry. NASA's Science Mission Directorate supported the Peregrine development project as a purpose-built sounding rocket sustainer motor using an approach where the government collaborates with industry to generate a build-to-print system that can be produced by multiple vendors.

The Agency initiated Peregrine when a long-term sounding rocket motor, used by NASA and other agencies, developed instability issues. Wallops approached Marshall to lead the development of Peregrine.

All design work, analyses, and materials identification were done at the Center. Marshall worked with the customer's sounding rocket program to identify requirements and is now collaborating with suppliers to produce the motor. Peregrine demonstrates Marshall's range of technical capabilities and ability to collaborate successfully with others.

Through the Peregrine project, multiple NASA centers are working together with industry to realize an economical, reliable solution. Rather than being dependent on a single supplier, NASA benefits by owning a design it can specify to industry for manufacture.

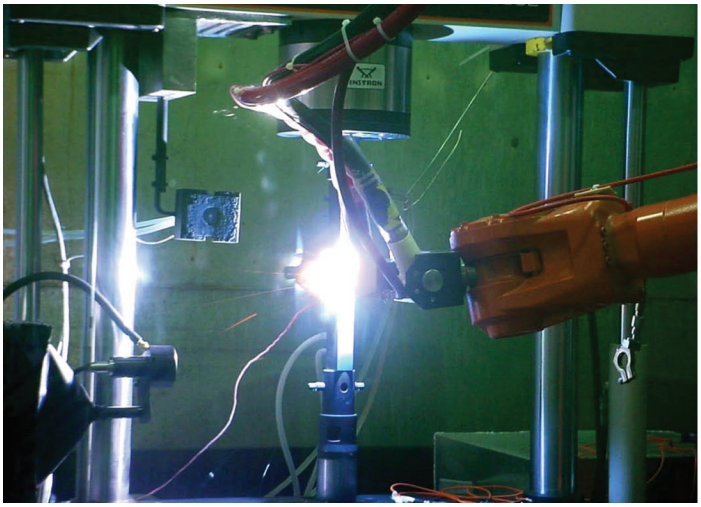
Marshall is collaborating with Wallops to develop the Peregrine sounding rocket motor.

Lead NASA Center for Design, Analysis, Test

Marshall, the hub of solids, is the recognized NASA center for solid propulsion development. The Center has a long history of solid motor development expertise with decades of experience in technical design, analysis, and testing of solids. Marshall's experience extends beyond motors and propellants to the associated technologies necessary for solid propulsion, including igniters, casings, and liner materials for use in solid rocket motors of any size.

Solid Rocket Motor Performance Prediction software is widely used to understand the ballistics (internal flow) of a solid motor. Marshall maintains current software versions — an important capability for both ballistic design and analysis. Thermal analysis is another Center capability that is key to good motor design and analysis. Marshall has world-renowned experts who helped produce the best available software in this field. Structural analysis and computational fluid dynamics are also key capabilities. Marshall can analyze combustion stability and internal acoustics to determine design weaknesses.

Marshall performs tensile tests, mechanical property testing, chemical analysis, and sophisticated chemical species analysis. The Center's Plasma Torch Testing Facility provides inexpensive verification of thermal properties. Additional capabilities include fracture mechanics, nondestructive evaluation, CT-scan and conventional X-ray, and ultrasonic scan. These testing skills also qualify us to perform mishap evaluations. Marshall is the only NASA facility that can test fire solid rocket motors from small to mid-size.



Thermal properties are tested at Marshall's Plasma Torch Test facility.

Close Collaboration with Industry and Government Partners

The Marshall solid propulsion team has world-renowned expertise in solids from small separation motors to heavy-lift applications, and has built a collaborative, customizable, and reliable development capability to work with industry teams to solve problems. This team has a fundamental development capability and conducts research in state-of-the-art technology. Marshall's solid propulsion team has close ties with the solid propulsion industrial base through its long history of operational programs. Marshall is actively engaged in national policy and program forums addressing solid propulsion industrial base sustainment and procurement efficiencies.

A unique facility partnership with the Army Aviation and Missile Research Development and Engineering Center (AMRDEC) makes Marshall the only center that can design, manufacture, and test large motors. The Agency and taxpayers benefit from Marshall's partnership with the onsite Army manufacturing facility to allow casting and mixing of energetic propellants.

Advanced Development and Future Mission Applications

Marshall has extensive experience with in-space motors that propel scientific payloads into the correct trajectories. Marshall's solid propulsion experts are collaborating with the Solar Probe Plus (SPP) third stage motor supplier in the development process and supporting NASA's Independent Program Assessment Office in their assessment of SPP.

Marshall is actively engaged in future mission applications including nano-launch, low-cost sounding rockets, sample return/ascent technologies, printable rockets, and extinguishable, restartable propellants. Currently, Marshall is working with industry to explore a new propellant technology that can be ignited, extinguished, and re-ignited multiple times by applying and removing an electrical current. This extinguishable solid propellant technology could be used on small in-space propulsion projects, allowing these small satellites to benefit from the high volumetric efficiency of solid propellants. Recent research has also explored improving the efficiency of propellant mixes, and Marshall is currently testing propellants for exposure to simulated Mars environments in support of future sample return mission concepts.

Marshall's work on booster separation motors for the Space Launch System and the Launch Abort System for Orion illustrates the Center's ability to scale its solid propulsion capabilities to any spacecraft size or mission need. In addition, Marshall's expertise extends from initial design to manufacturing oversight, testing, and operational support.

The successful test firing of the Orion jettison motor is the first full-scale rocket propulsion element qualified to proceed into a system-level demonstration.

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