

Mechanical and Materials Engineering



fatigue testing • computational fluid dynamics • deep ocean simulations • fracture mechanics • probabilistic failure analysis • environmental testing • surface engineering & coatings • flow measurement • pipeline compression & measurement • biomechanics & biomaterials • life prediction • acoustics • thermal analysis • diagnostic software • corrosion analysis • impact modeling • finite element analysis • NEBS qualification • computational mechanics • structural mechanics • failure analysis • engineering dynamics • aerodynamics • mechanical testing • material integrity • terminal ballistics

Continuing unrest in the Middle East is affecting the energy arena and driving programs to develop technology to protect our military forces. In response, Southwest Research Institute continues extensive programs for the oil and gas industries and is developing current and future **vehicle protection systems and armaments**. Building on our expertise in materials characterization, staff members are developing new capabilities in sensors, multi-scale modeling and integrated systems health management to improve the reliability and extend the life of aging infrastructure, from pipelines to aircraft.

For the last 25 years, SwRI has been involved in **structural analysis of aging military aircraft** (aerospacestructures.swri.org). This year, we expanded our program to full-scale static and fatigue certification testing of commercial aircraft designs for the Eclipse 500 very light jet. We performed Federal Aviation Administration **design certification testing** for this new class of jet, and we will continue fatigue testing to extend its certification for additional operating conditions.

SwRI is helping the U.S. Marine Corps address **corrosion and reliability issues** and is transferring this expertise to other fields, such as the pipeline industry (corrosiontechnology.swri.org). New **integrated systems health management** technologies more effectively identify where corrosion is likely to develop. We are also using remote monitoring technologies to detect corrosion in flowing gas pipelines or petrochemical applications.

We are integrating new nano-structured **thin-film sensing** technology with **probabilistic life prediction** analysis to monitor the health and predict the reliability of mechanical systems or components. Although this technology is applicable to a wide range of high-value assets, the initial focus is on performance prediction and maintenance scheduling of military helicopters and aircraft turbines with the goal of providing more cost-effective and reliable operations.

Through a joint industry program, SwRI is developing a database and guidelines for the safe usage and compatibilities of materials and the heavy brine packer fluids used in oil and gas well production. These corrosive brines can corrode production tubing materials under specific conditions or in association with incompatible materials.



Fluid spin-up transients in large spacecraft fuel tanks can significantly affect vehicle stability. SwRI evaluated the Dawn spacecraft's fuel tank to measure transient effects using a surrogate fluid to simulate the actual propellant. The test results will enhance the launch vehicle stability control system (multiphase.swri.org).

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We conducted certification testing of a commercial aircraft design, performing full-scale Federal Aviation Administration design certification testing for the Eclipse 500 very light jet (inset), a new class of aircraft. A new 7,000-square-foot, temperature- and humidity-controlled high bay facility enhances our capabilities in this area and with other large structures.



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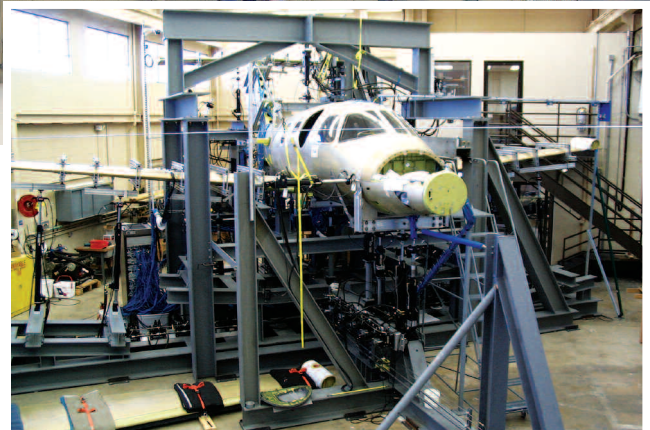
New expertise in **multi-scale modeling** numerically simulates the behavior of materials, including nanomaterials, at multiple length scales. To extend the life of high performance and biomaterials systems, our engineers apply an **integrated life management** program that fuses fatigue, corrosion and reliability evaluations with sensor, signal processing, modeling and other technologies.

As military tactics evolve and rules of engagement shift, SwRI is conducting numerous programs designed to protect soldiers in today's battle zone. Our staff is developing technologies designed to keep personnel out of harm's way, including autonomous weapon and vehicle technologies to perform **unmanned military operations**. SwRI is also evaluating potential new armor designs, conducting fundamental studies of armor materials and creating new lightweight, low-cost armor concepts (engdyn.swri.org).

To increase domestic energy supplies, we are continuing our work in multiphase flow and pipeline reliability, integrity and efficiency (oilgas.swri.org). We are applying this expertise in a new arena, developing more **efficient compression technology** to sequester and re-inject carbon dioxide emissions from coal-burning plants. This technology creates a cleaner coal gasification process while enhancing petroleum reservoir production. SwRI has also developed unique capabilities to test the fatigue, stress corrosion cracking and corrosion of materials in sour gas environments and is developing innovative coatings to reduce hydrate formation in production systems.

In 2006, we continued our **hydrogen storage materials** evaluation program (hydrogenstorage.swri.org). SwRI is developing the **certification standards** for fuel cell storage materials for automotive and other transportation applications.

We also began the design phase for the crew pressure hull of the **next-generation ocean research submersible**.



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Designed to replace Alvin, which has a titanium hull able to withstand depths of 4,500 meters, the new vehicle will dive to 6,500 meters, allowing access to 99 percent of the ocean floor (structuralsystems.swri.org). ❖

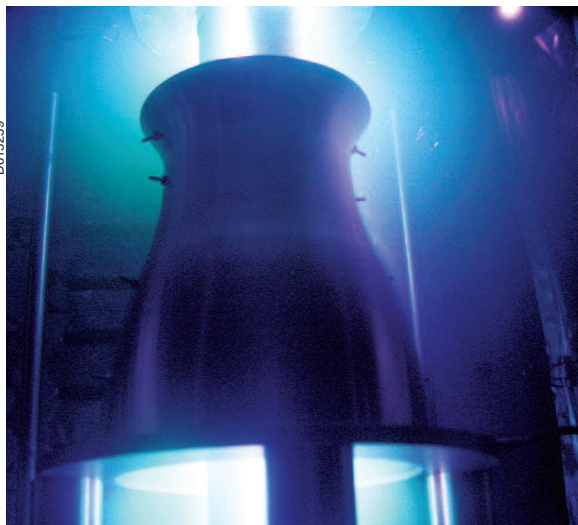
Visit mechmat.swri.org for more information or contact Vice President Dr. Robert L. Bass at (210) 522-2326 or robert.bass@swri.org.



SwRI detonated 1,250 pounds of ammonium nitrate at a remote test facility to study the effectiveness of blast-resistant windows and other protective structures. This image, captured from high speed video, shows the shock wave produced by the blast.

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SwRI developed a process for applying nano-structured copper-chromium coatings to metal components used in hot, oxidizing environments, such as rocket nozzles and gun barrels. The process, which limits component oxidation and pitting to prolong operating life, has important applications for manned space flight and national defense (surfaceengineering.swri.org).



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