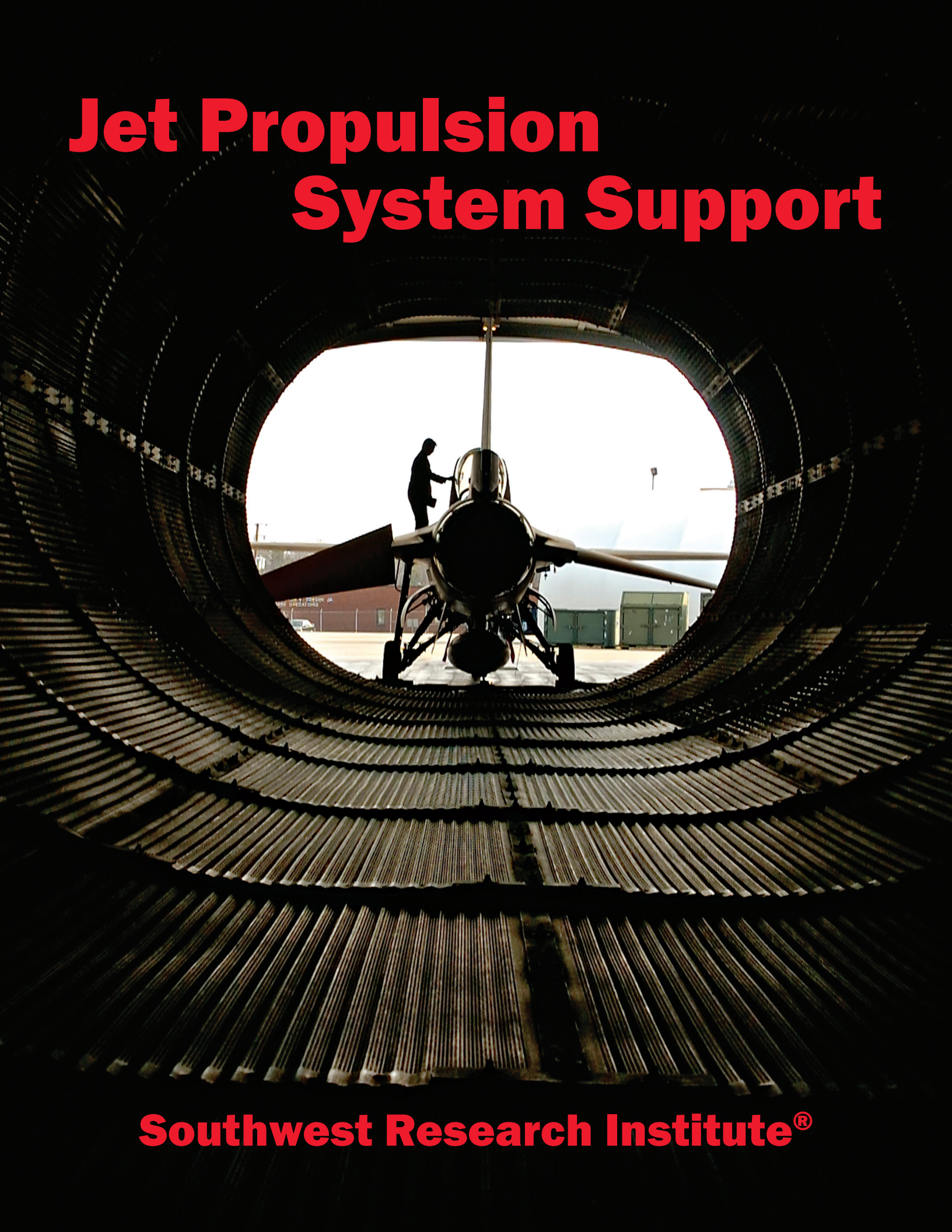
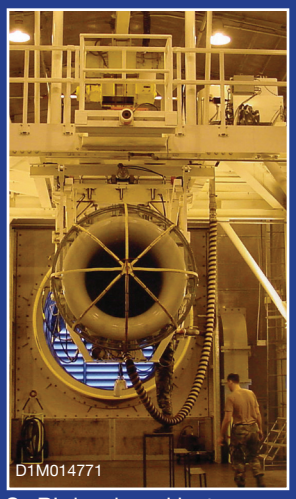
Jet Propulsion System Support



Southwest Research Institute®



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SwRI developed instrumentation for the thrust frame and adapter kit used to test engines for the Air Force.

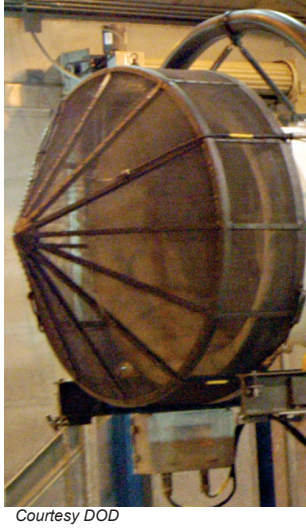
Southwest Research Institute

Founded in 1947 as an independent, nonprofit research and development organization, Southwest Research Institute provides a significant research, engineering and testing resource for industry, business and government. The Institute uses a multidisciplinary, integrated approach to solving complex problems in science and applied technology. As part of a long-held tradition, patent rights arising from sponsored research at the Institute are often assigned to the client. SwRI generally retains the rights to Institute-funded advancements.

About the cover D016457
Preparing an F-16 Fighting Falcon for an engine test run.

Courtesy
U.S. Air Force/Tech. Sgt. Ben Bloker

Jet Propulsion System Support



Courtesy DOD

From jet propulsion requirements and facility design, to systems and software development, Southwest Research Institute® (SwRI®) provides experienced and timely jet propulsion systems solutions. For nearly 20 years, SwRI has provided jet engine propulsion services and advice on test and repair facilities to the U.S. Air Force, Army and original equipment manufacturers (OEM). SwRI is a recognized leader in developing innovative solutions and providing independent engineering assessments, including:

- Engine test cell instrumentation
- Test cell facilities and equipment
- Engine test software
- Calibration and certification of test cells
- Engine trending and diagnostics (ET&D)
- Engine trending and analysis training development and delivery
- Engine component test stations

SwRI's success in engine and engine component testing is based on a multidisciplinary systems engineering approach to problem solving. Comprehensive expertise in design, modeling, fabrication and integration enables SwRI to address client needs.

SwRI has implemented an ISO 9001:2000 compliant program for all design and manufacturing processes, including engineering analysis tasks and software development efforts.

Test Cell Components

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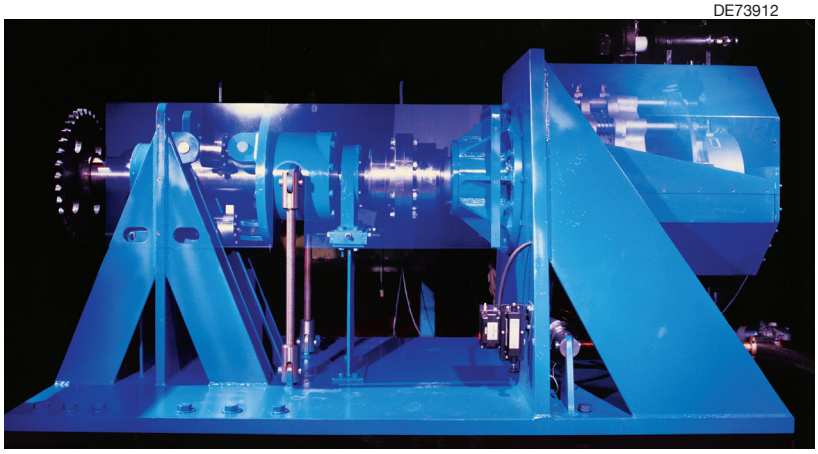
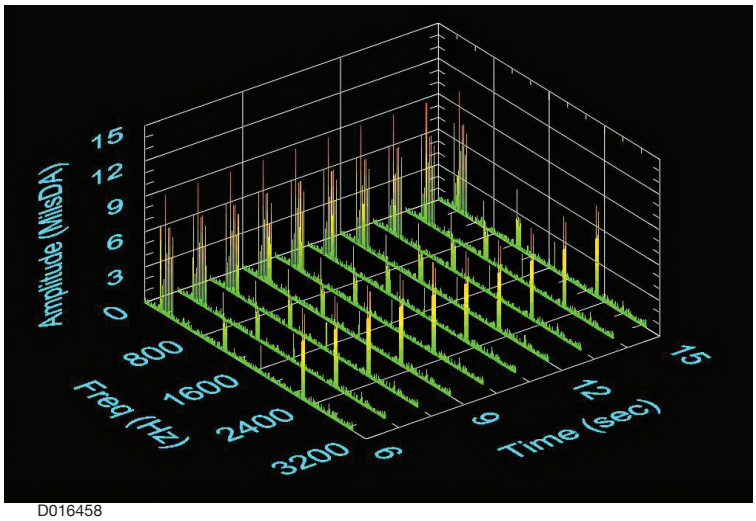


SwRI developed a dynamometer test stand to evaluate high-torque engines.

Thrust Frames
SwRI engineers designed and fabricated a unique dynamometer test stand configured to accept and measure 250 ft.-lb. to 25,000 ft.-lb. of torque and 80,000 lbs. of thrust at speeds up to 200 rpm.

Noise Suppressors
SwRI engineers have developed plant layouts and design detail options for an engine test facility to evaluate large engine-generator sets fabricated by the client. Exhaust emissions, acoustic noise and ground-borne vibrations from the engine generators were key topics of consideration.



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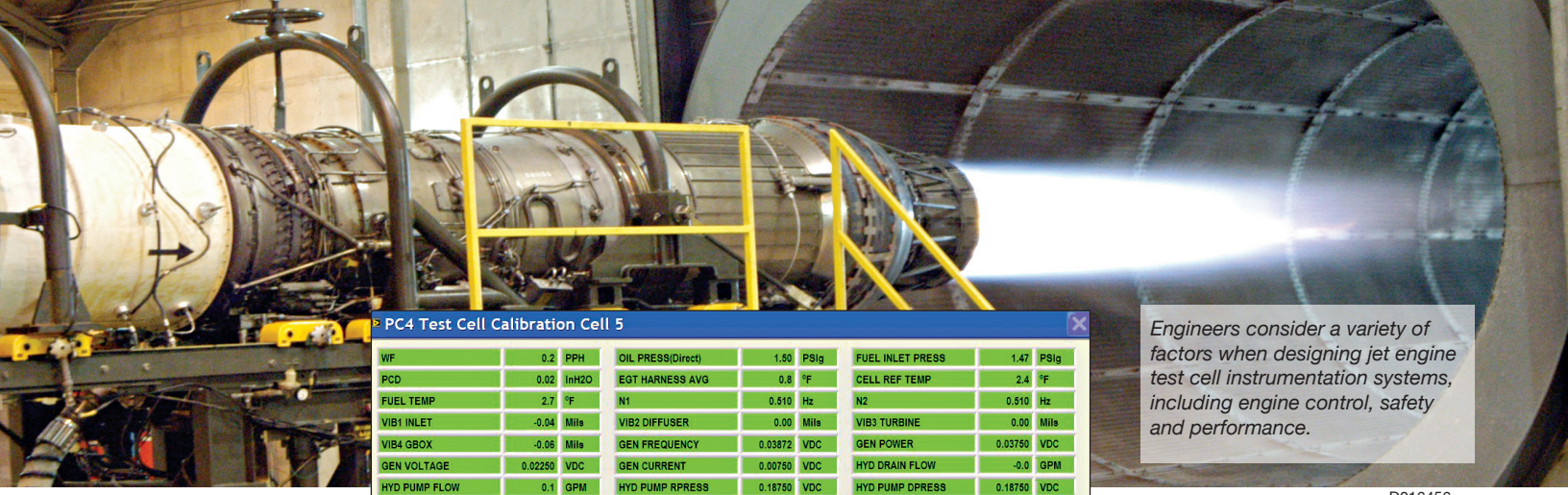
Automation Software
Implementation of the automated and semi-automated control of a jet engine test evolved from operational and performance tests included in technical manuals. SwRI is adept at developing test software from requirements to acceptance testing and post-delivery software maintenance.

SwRI developed system software for the Air Force that communicates between hardware and software used at engine test cells in the field. This image shows an engine vibration waterfall plot developed with the software.



Engineers consider a variety of factors when designing jet engine test cell instrumentation systems, including engine control, safety and performance.

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Test Cell Support

Calibration

Using instrumentation error analysis over normal ambient conditions of the test cell and coordination with engine manufacturers, SwRI instrumentation engineers develop technical data to calibrate intermediate and depot jet engine test cells. Software engineers implement semi-automated calibration software and are knowledgeable in error calculations such as SAE ARP4990 for calculating fuel flow in turbine flowmeters. SwRI also coordinates calibration requirements with various calibration organizations, such as the Air Force Precision Measurement Equipment Laboratory (PMEL), Air Force Metrology and Calibration (AFMETCAL) program and the on-site quality team, including development of Calibration Measurement Requirements Summary (CMRS) documents.

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SwRI engineers develop technical data and software to perform semi-automated calibration of jet engine test cells.

Throttle Controls

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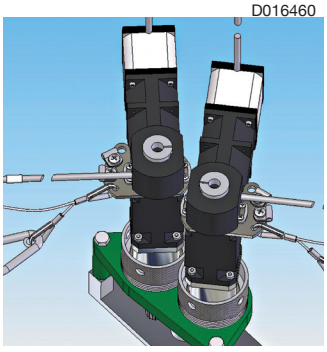

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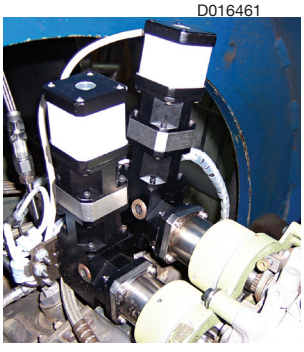

Engineers use solid modeling tools to design engine throttle controls.

Design considerations for engine throttle controls include redundancy and safety, operator ease of use, alignment, computer interface, and application given the cost drivers. Local closed-loop control of stepper motors are used to achieve ±0.25 degree power lever angle repeatable commandable set points. Ramp rates and safety cutback and shutdown commands also are featured.

Test Cell Instrumentation Design

When designing a test cell instrumentation system, SwRI engineers consider control of the engine; measurement of safety, performance and facility parameters; and performance calculations. Safety shutdown and redundant safety parameters, such as engine speeds, engine temperature and fuel flow, provide a safety net to the operator. Engineers also interface with engine buses (such as MIL-STD-1553B) for parameter acquisition and take into account measurement characteristics such as linearity, temperature sensitivity, hysteresis, resolution, shielding and grounds, and National Fire Protection Agency (NFPA) regulations. Design encompasses selection of sensors, data acquisition, data processing, data display/recording equipment, and special interfaces and cabling.

Test Cell Correlation/Certification

SwRI engineers have more than 20 years of experience in performing jet engine test cell correlation, which is required to ensure standardization of all testing facilities that certify serviceable status of the same Type/Model/Series (TMS) turbofan, turboshaft and turbojet engines. The typical reference base is an engine, provided by the OEM, that is baselined for all gas path parameters to meet specification requirements. Running the calibrator, data collection, data analysis and (as required) correction back to baseline is mandated because each facility is unique. SwRI is working on a new method to correlate test cells using an engine cycle model when a test cell undergoes a significant modification of the physical structure or the instrumentation system hardware or software.

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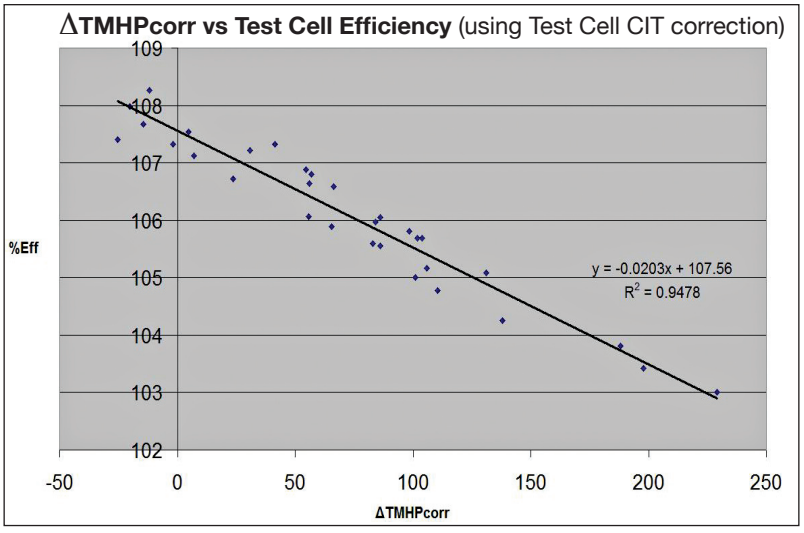

Test cell correlation analysis software measures engine efficiency and plots correlation correction paths.

Southwest Research Institute is an independent, nonprofit, applied engineering and physical sciences research and development organization using multidisciplinary approaches to problem solving. The Institute occupies more than 1,200 acres and provides more than 2 million square feet of laboratories, test facilities, workshops and offices for nearly 3,300 employees who perform contract work for industry and government clients.

Benefiting government, industry and the public through innovative science and technology

We welcome your inquires.
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