

Automotive Engineering



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SwRI engineers have developed a unique hardware-in-the-loop test facility to decrease development costs and the time to market new component designs. The HIL facility shown will develop and evaluate advanced conventional and hybrid powertrains.

gasoline & diesel engine lubricant evaluations • driveline fluids evaluations • filtration evaluations
fuels performance & qualifications • analytical support services • fuel economy evaluations
fuel & lubricant surveys, sampling & analyses • screener development • computational fluid dynamics
fire-resistant fuels • technology support to developing countries • model-based controls • engine design
emissions reduction • transmission design • natural gas engine development • materials compatibility
alternative fuel evaluations • powertrain modeling & controls development • engine development

With more than 60 years of experience in engine and vehicle component design and development, engine and emissions research, and fuel and lubricant evaluations, Southwest Research Institute pulls together staff members from a wide variety of disciplines to tackle our clients' on- and off-road vehicle projects from every direction. Our development and evaluation capabilities are internationally recognized and meet the highest quality standards.

Our automotive design services range from complete engine design to detailed component analysis (engine.design.swri.org). For one commercial client, we designed and analyzed a unique two-cylinder, split-cycle prototype engine. Unlike the typical four-stroke process used by standard gasoline and diesel engines, this engine splits the two sets of strokes into two separate cylinders; the intake and compression strokes take place in one cylinder and the expansion and exhaust strokes take place in the other. This design optimizes the compression and combustion processes, believed to provide significant exhaust emissions advantages, and potentially enables a cost-effective air-hybrid engine design.

We designed a new cylinder head to help heavy-duty diesel engines meet forthcoming international emissions standards. Engine and vehicle original equipment manufacturers from around the world have shown interest in the design's potential to achieve 250-bar peak cylinder pressure.

Our Ann Arbor, Mich., staff continues supporting the Environmental Protection Agency's Clean Automotive Technology program, which involves the development of custom hydraulic hybrid control modules to maximize fuel economy on delivery vehicles (annarbor.swri.org).

As part of the Advanced Collaborative Emissions Study organized by the Department of Energy with the Coordinating Research Council and the Health Effects Institute, our engineers examined emissions from four 2007 model year, heavy-duty highway diesel engines, characterizing regulated emissions, ultrafine and nano-particles, and more than 795 unregulated species in the gas and particle phase. The study confirmed the engines successfully achieved lower emission levels than those mandated by the 2007 standard while reducing the great majority of unregulated pollutants, compared to pre-2007 technology engines (emissionsresearch.swri.org).

As the focus on renewable fuels sharpens, legislation is requiring suppliers to confirm that new fuel formulations

do not increase vehicle emissions or cause engine and vehicle durability issues. For EPA, DOE, the National Renewable Energy Laboratory and the Coordinating Research Council, our researchers are examining the fuels' effects on light-duty vehicle emissions. For DOE and the Oak Ridge National Laboratory, we also are assessing the effects of ethanol blends on catalytic converters and long-term vehicle emissions.

To help advance pre-competitive technologies, SwRI organizes cooperative research programs that allow members to pool funds to develop new technologies at significantly lower cost. SwRI initiated the Diesel Aftertreatment Accelerated Aging Cycles — Heavy Duty consortium to develop application dependent, accelerated aging procedures for diesel aftertreatment components, which could save both time and expense to achieve certification requirements (daaac.swri.org). Current members include engine manufacturers from the United States, Japan, Europe and Korea, as well as lubricant and catalyst companies.

Our High-Efficiency Dilute Gasoline Engine consortium continues to develop the enabling technologies required for gasoline engines to meet the performance, durability and emissions requirements of future motor vehicles while improving efficiency. HEDGE™ has 17 members representing engine manufacturers, component suppliers, and oil and gas providers (hedge.swri.org).

In 2009, the U.S. Army renewed its long-term contract with SwRI to operate the Tank Automotive Research, Development and Engineering Center Fuels and Lubricants Research Facility

1. For a commercial client, SwRI engineers are developing a split-cycle engine that directs intake and compression strokes into one cylinder and expansion and exhaust strokes in another. Preliminary analysis suggests the design can help reduce emissions (engine.design.swri.org).

2. Our engineers designed and built a hydraulic fluid energy efficiency test stand that precisely measures energy efficiency gains of reformulated hydraulic fluids.

3. SwRI designed a new U.S. Army TARDEC Ground Systems Power and Energy Laboratory to evaluate the environment, power, electrical power architecture systems, electric components, pulse power and directed energy, thermal fluids, fuel cells and air flow filtration of an array of military vehicles (tardec.swri.org). GSPPEL will be built alongside TARDEC's existing test facility, shown in blue, at the Detroit Arsenal in Warren, Mich.

*high-efficiency gasoline engine research • generator set & combined heat & power evaluations
homogenous charge compression ignition • hydraulic design • hardware-in-the-loop evaluations
light-duty fuel economy & production calibration • marine & recreational products & research
hybrid vehicle design • vehicle testing • contamination research • wear evaluations
accelerated durability evaluations*

(tardec.swri.org). The laboratory helps the military meet operational and readiness requirements by investigating and solving problems with vehicle fluids. Army-funded laboratory renovations are ongoing and will allow for the continuation of the Army's fuels and lubricants research mission, which includes the adoption and use of sustainable energy resources and alternative fuels in the present and future Army fleet.

SwRI designed a new Ground Systems Power and Energy Laboratory to be built alongside TARDEC's existing facility in Warren, Mich. The Army will use the facility, which broke ground in August, to examine existing military vehicles and to assess the viability of developing hybrid-electric and fuel-cell military vehicles.

SwRI has performed comprehensive fuel economy evaluations on fluids and automotive devices for the trucking industry for more than 20 years (fuelconomytesting.swri.org). In accordance with industry standards, we evaluate fuel consumption during operating cycles representative of bus, pick-up and delivery, and refuse operations, as well as long-haul truck fleets. Staff members use a dedicated scale accurate to 0.1 pound and consistent driving patterns to maintain accuracy. Vehicle operating conditions such as truck and engine speed, coolant temperature and turbo boost pressure also can be monitored and recorded.

Increasingly stringent fuel economy regulations are creating higher demands for vehicle, component and fluid evaluations. In addition to offering a multitude of evaluation services, SwRI has taken a lead role in developing new test methods and systems (enginelubes.swri.org).

We recently designed and built a new test stand that precisely measures energy efficiency gains associated with improved hydraulic fluids for oil and additive manufacturers. Mobile and plant equipment use massive amounts of energy to power hydraulics so small gains in efficiency can create significant economic gains.

ASTM International recently accepted the ROBO test procedure co-developed at SwRI for inclusion in the next engine oil category, GF-5. The test evaluates used oil low-temperature performance in the Sequence IIIGA test, one of a series of specifications engine oils must meet before entering the global marketplace. The GF-5 specification targets emission system compatibility and engine cleanliness, as well as fuel economy and fuel economy retention.

ASTM also accepted the SwRI co-developed Sequence VID fuel economy test, which will be used by the lubricants industry over the next several years in every engine lubricant fuel economy evaluation we conduct.

We have been a major participant in working to finalize development for the American Petroleum Institute's next gasoline engine lubricant specification, designated SN. SwRI's contributions to the Sequence VID economy test and the ROBO analytical bench test were key to the development of this specification.

Our engineers helped develop the new catalyst-compatible FC-W specification, approved by the National Marine Manufacturers Association, designed to limit catalyst poisoning in four-stroke marine engines.

Our internal research program helps fund the advancement of new automotive test methods and systems. Using this funding, we are developing a standard method to identify and quantify eight polycyclic aromatic hydrocarbons, which are used in tire manufacturing in Europe. The new method will measure these hydrocarbons in low concentrations with high precision and accuracy, assuring the quality of the oil before it is used in the manufacture of tires. ❖

Visit fuelsandlubricants.swri.org or engineandvehicle.swri.org for more information or contact Vice President Lee Grant at (210) 522-5004 or lee.grant@swri.org or Vice President Bruce Bykowski at (210) 522-2937 or bruce.bykowski@swri.org.

4. *The South Texas climate provides ideal weather for conducting on-road fuel economy evaluations for the trucking industry year-round. Our engineers evaluate the vehicles on public highways and roads, at grades up to 11 percent. We also maintain a paved test track with 0.6-mile straightaways at our 1,200-acre headquarters in San Antonio.*

5. *A new test cell developed at SwRI evaluates vehicle radiators, coolants, and related components and fluids from vehicles ranging in size from compact cars to Class 8 trucks and military vehicles under a variety of conditions. As an independent research and development organization, SwRI provides third-party verification testing of these systems.*

6. *We successfully integrated our Prism® data acquisition software into SwRI mileage accumulation dynamometers. The first stand is now in service with Prism controlling the critical road load force parameters more closely than the software program it replaces.*