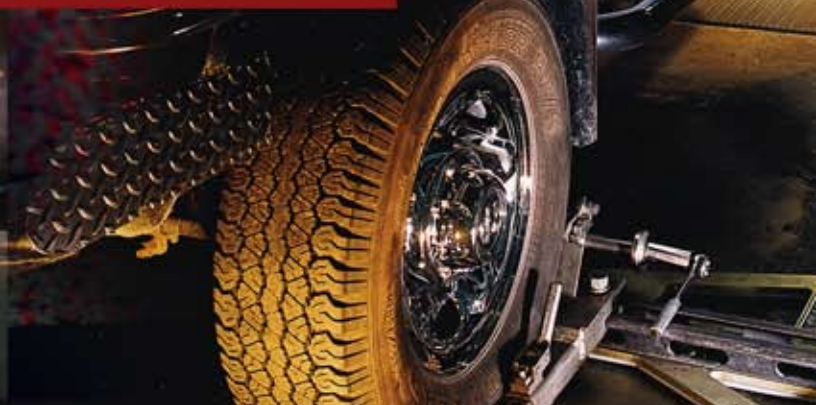


# *Automotive Engineering* Capabilities

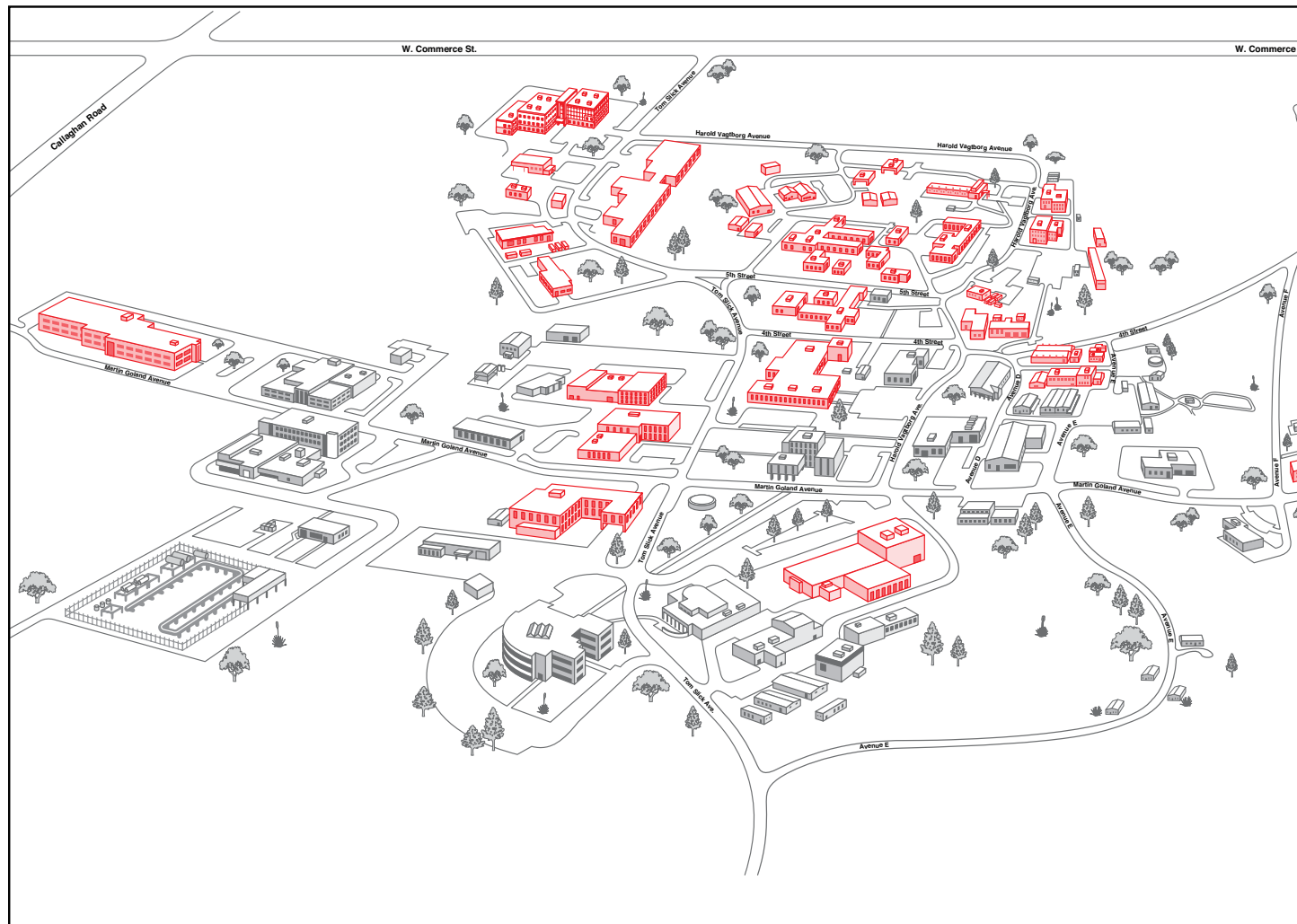
Southwest Research Institute® San Antonio, Texas



## Southwest Research Institute

Since its inception in 1947, Southwest Research Institute (SwRI®) has dedicated extensive resources toward serving the automotive industry. Today, almost one-third of SwRI's more than 3,300 employees work on automotive projects that range from vehicle concept through production. This work may involve automotive vehicle systems, engines, fuels and lubricants, emissions, electronics, automation and robotics and other related programs. SwRI provides the automotive industry with technology development and engineering services such as designing, modeling, simulating, analyzing, testing and prototyping.

For additional information see our web site at [swri.org](http://swri.org).



The map above indicates (red buildings) facilities in which project work for the automotive industry is performed.

## Automotive Engineering

Automotive Engineering at Southwest Research Institute in San Antonio, Texas, brings together the world-class technical expertise and diversity of operations in the Fuels and Lubricants Research Division and the Engine, Emissions and Vehicle Research Division to more effectively offer complementary technologies to SwRI automotive clients.

These synergies improve cost-effectiveness, utilize existing resources and provide a single and formidable technology base to our transportation and energy industry clients worldwide.

Automotive Engineering at SwRI is certified to ISO 9001:2000 "Quality Management Systems – Requirements," accredited to ISO/IEC 17025:2005 "General Requirements for the Competence of Testing and Calibration Laboratories" and certified to ISO 14001:2004 "Environmental Management Systems." The divisions also have achieved Ford Tier 1 status for providing engineering services and have received the Ford Q1 Quality Award.

This document summarizes, in a listing format, the capabilities available from the Automotive Engineering divisions. For specific details on any of the capabilities listed here, please contact:

Bruce Bykowski  
Vice President  
Engine, Emissions and  
Vehicle Research Division  
(210) 522-2937  
[bbykowski@swri.org](mailto:bbykowski@swri.org)  
[eevrd.swri.org](http://eevrd.swri.org)

Lee Grant  
Vice President  
Fuels and Lubricants  
Research Division  
(210) 522-5004  
[lgrant@swri.org](mailto:lgrant@swri.org)  
[flrd.swri.org](http://flrd.swri.org)



# Capabilities of the Engine, Emissions and Vehicle Research Division

eevrd.swri.org

**T**he Engine, Emissions and Vehicle Research Division conducts design, development and test programs on a wide range of components, engines, transmissions and vehicles. This is supported by research and modeling of fuel mixing, combustion, tribology, filtration, structural analysis, NVH and fluid flow. The division organizes multi-client cooperative industry research programs in many areas to help manufacturers achieve lower exhaust emissions and to increase fuel economy. The division also develops specialized instruments, control systems, test apparatus and data acquisition systems to aid in achieving engine and vehicle performance and emissions goals.

The Engine, Emissions and Vehicle Research Division and the Fuels and Lubricants Division are certified to ISO 9001:2000 “Quality Management Systems - Requirements” and ISO 14001:2004 “Environmental Management Systems.” The Emissions Research and Development Department is accredited to ISO/IEC 17025:2005 “General Requirements for the Competence of Testing and Calibration Laboratories.” The division has also achieved Ford Tier 1 status for providing engineering services and has received the Ford Q1 Quality Award.

Bruce Bykowski, *Vice President*

Magdi K. Khair, *Institute Engineer*

Charles E. Roberts Jr., *Institute Engineer*

Thomas W. Ryan III, *Institute Engineer*

The Engine, Emissions and Vehicle Research Division is currently organized into three departments:

## **Engine and Vehicle R&D**

- Aftertreatment R&D
- Diesel Technology
- Powertrain Controls
- Advanced Vehicle Technology
- Advanced Combustion and Emissions

## **Emissions R&D**

- Engine Certification and Emission Development
- Chemistry and Particle Science
- Medium Speed Diesel Engines
- Light-Duty Vehicle Emissions
- Aftertreatment Technology

## **Design and Development**

- Engine Development
- Engine Design and Analysis
- Drivetrain Design and Development
- United Kingdom Design Office

**Aftertreatment Research and Development**

- Diesel Aftertreatment Accelerated Aging Consortium
- Aftertreatment technology design, development, testing, integration
- Catalyst research and development
- Gasoline catalyst aging and evaluation
- Synthetic gas reactor
- Non-thermal plasma studies
- Diesel particulate filter
  - Filtration efficiency measurement
  - PM mass and soluble organic fraction measurement
  - DPF balance point determination
  - Ash accumulation and analysis
  - On-vehicle performance and durability testing
  - DPF plugging investigations and cleaning strategies
  - On-board diagnostics
  - Regeneration strategy development
  - Pressure drop evaluation
- Light- and heavy-duty DPF durability test procedure development
  - On-vehicle exhaust system environment measurement
  - Accelerated test development
  - Automated PM loading and regeneration
- SCR catalyst system evaluations
  - NO<sub>x</sub> reduction performance
  - Urea dosing technology
  - Durability testing
- LNT system evaluations
  - NO<sub>x</sub> reduction performance
  - Regeneration and desulfurization strategy development
  - Durability testing
  - System integration
- Lubricating oil effects on diesel aftertreatment and sensors
  - DPFs, cDPFs, DOCs, LNTs, SCR, NO<sub>x</sub> sensors
  - Catalyst deactivation
  - Poisoning mechanisms
  - Ash exposure

**Diesel Technology**

- Clean Diesel Engine Research Consortium
- Light-duty diesel engine research and development for U.S. Tier 2 and Euro 5/6
- Heavy-duty diesel engine research and development for U.S. 2010 emissions standards and beyond
- Aftertreatment integration and control
  - Diesel oxidation catalyst (DOC),
  - Diesel particulate filter (DPF),
  - Lean NO<sub>x</sub> trap or adsorber (LNT),
  - Lean NO<sub>x</sub> catalyst (LNC), and
  - Selective catalytic reduction (SCR) systems.
- Alternate combustion mode implementation
- Combustion system analysis and calibration
- Fuel injection
- Urea spray analysis
- Nozzle development
- Evaluation of exhaust components

**Powertrain Controls**

- Control algorithm development for engine, transmission, vehicle systems
- On-board Diagnostics (OBD)
- Electronic stability control
- Accelerated engine calibration
- Software development for embedded CPUs
- Hardware development, experimental and production intent
- System design, integration, testing
- Controller calibration, automated mapping
- Algorithm, calibration optimization
- Modeling
- Hardware-in-the-loop simulation
- Signal processing
- Data analysis
- Rapid prototyping of powertrain, vehicle control systems
- Multiplexing and controller communications
- Hybrid vehicle control

**Advanced Vehicle Technology**

- Vehicle modeling and simulation
- Vehicle performance simulation
- Vehicle fuel economy simulation
  - Vehicle CO<sub>2</sub> and emissions simulation
  - Conventional drivetrain vehicle simulation
  - Vehicle control system simulation
  - Hybrid vehicle simulation
    - Base electric vehicle (BEV) simulation
    - Plug-in electric vehicle (PHEV) simulation
    - Range extending electric vehicle (REEV) simulation
    - Hydraulic hybrid vehicle simulation
    - Fuel cell vehicle simulation
- Vehicle prototype development, integration, testing, and evaluation
  - Hybrid vehicle research
  - Fuel cell vehicle research
  - Advanced energy storage system (ESS) vehicle research
  - Micro, mild, heavy duty hybrid vehicle research
- Vehicle conventional and hybrid control systems development
- Hardware-in-the-loop (HIL) systems
  - Development of HIL hardware/software systems
  - Enhanced testing using HIL systems
  - Transmission auto-calibration using HIL systems
- Fuel cell integration and testing
- Vehicle accessory component design, testing, and evaluation

**Advanced Combustion and Emissions**

- Gasoline Engine Research Consortium
  - High Efficiency Dilute Gasoline Engine (HEDGE)
  - Cooled EGR for gasoline fuel economy improvements
- Spark ignited engine R&D
  - CO<sub>2</sub> Reduction
  - Fuel economy improvement
  - Cold-start emissions reduction
  - Down-sized gasoline engines
  - Down-speeded gasoline engines
  - HCCI, ignition-assisted HCCI, PCCI, CAI development
- SI-Emissions solutions for current and future emissions compliance
- SI-Fuel economy solutions for current and future regulations (CAFE)
- CO<sub>2</sub> reduction solutions for current and future regulations
- Turbo- and super-charging for spark-ignition engines
- Turbocharger test stand facility for turbocharger testing and mapping
- EGR and airflow control strategy development for spark-ignited engines
- Spark-ignited engine design
- Combustion system design and development
- Flow and port-design and development
- High speed visualization facility (>100,000 fps)
- Custom solutions for laser-based combustion and emissions measurements
- Component design, development and testing
- Cycle simulation
- 3-D computational fluid dynamics, including moving valves, full combustion system
- Combustion and emissions performance simulation
- Knock modeling
- HCCI combustion and emissions modeling
- Durability testing
- Emissions development, including cold-start
- SULEV emissions strategy development and implementation
- Engine benchmarking
- Engine management system development
- Friction measurement and design for reduced friction
- Injectors, fuel spray characterization and injector targeting
- Low-temperature testing, including cold-start strategy development
- Real-time oil consumption measurement
- Spark plug testing
- Ignition system development and testing
- Valve recession control

**Engine Certification and Emission Development**

- On-highway diesel engines
- Nonroad and European diesel engines
- Forklift and spark-ignited off-highway engine
- Personal watercraft, snowmobiles and marine engines
- Conventional, alternative fuels, additive effects on emissions
- Engine and emission control performance
- High altitude engine and vehicle evaluations
- Emissions sampling
- Test cycle development
- Chassis testing of heavy-duty vehicles
- Retrofit evaluation for system development
- Component development and evaluation

**Alternative Fuels Evaluation**

- Compressed and liquefied natural gas
- Liquefied petroleum gas
- Ethanol
- Methanol
- Coal and water slurries
- Biodiesel
- Vegetable oils
- Dimethyl ether
- Fischer-Tropsch liquids

**Particle Science**

- Detailed assessment of particulate mass, number and size distribution in real time
- Ultrafine and nanoparticle emissions measurement from:
  - Different combustion sources
  - Different fuels
  - Light- and heavy-duty engines and vehicles
  - Exhaust after-treatment devices
- Semi-continuous measurement of particle organic carbon and elemental carbon
- Solid particle number standard measurement using the PMP sampling protocol for Euro V or VI
- Real-world particle emission evaluation of retrofit devices on mobile and stationary sources
- Exhaust particle sensor development and testing
- Dilution system development and testing for different applications
- Particle instrument calibration using NIST Traceability

- Small DPF efficiency evaluation using soot particle generation
- Mechanism of fouling in EGR cooler and intercooler caused by particle deposition
- Development of highly sensitive measurement systems for crack detection in DPFs
- Fundamental understanding and real-time measurement of particle formation under DPF active regeneration
- Particle deposition in various systems using theoretical assessment
- Consulting services, seminars and literature reviews

**Chemistry**

- Exhaust gas speciation; toxic species analysis
- Analytical procedure development
- Fuel and fuel additive registration evaluations
- Spark and compression ignition engine fuel, additive effects
- Unregulated pollutant speciation

**Medium Speed Diesel Engines**

- Locomotives
- Stationary power plants
- Gas compressors
- Marine engines
- Offshore drilling
- Power generation
- Alternative fuel evaluations
- Emissions research
- Control system development
- Engine performance improvement
- Engine and component design
- Fuel injection system development
- Standardized testing, services
- Modeling
- Noise evaluation
- Engine familiarization workshops

**Light-duty Vehicle Emissions**

- Off-cycle test conditions, temperatures
- Periodic testing during mileage accumulation
- Diesel property effects studies
- Gasoline property effects studies
- Evaporative emission measurement
- Lubricant property effects
- Evaporative emissions and controls
- Emissions at high and low temperatures

- Alternative and flexible fuel vehicle research
- Motorcycle and ATV chassis dyno and emission measurement

**Aftertreatment Technology**

- Exhaust system durability
  - Hot vibration testing
  - Thermal cycling
  - Water quench testing
  - Thermal profile testing

- EGR cooler and systems durability
- Exhaust system validation
- Fouling and thermal efficiency
- Accelerated corrosion testing
- Metallurgical evaluation of EGR system components
- Alternative fuels effects on aftertreatment systems

**Drivetrain Design and Development**

- Design, Development and Test Hardware
  - Gearboxes
  - Stepped ratio
  - Continuously variable
  - Hybrid
  - Hydromechanical
  - Split power
  - Transfer cases
  - Axles
  - Differentials
  - Gears
  - Clutches
  - Housings
  - Torque converters
  - Axles
  - Differentials
- Design
  - Packaging and layout
  - Feasibility and technology studies
  - Concept design and development
  - Detailed design
  - CAD modeling and revision control
  - Prototype and production level design
  - Fabrication and assembly services
- Analysis and Simulation
  - Kinematic
  - Dynamic modeling
  - Stress, FEA
  - Oil Flow, CFD
- Development
  - Hardware functionality and durability development
  - Noise, vibration and harshness development
  - Shift calibration and control
  - Prototype and product hardware development

- Test, evaluation and benchmarking
  - Efficiency testing of assembly and component including torque converter
  - Spin loss testing of assembly and component
  - Drag testing of clutches
  - Steady state and transient durability testing of assembly and components
  - Transmission durability – engine torsionals
  - Transmission durability – vehicle and road load dynamics
  - High and low temperature environmental testing
  - Oil level effects
  - Static and dynamic strength and fatigue
  - Case and seal leakage
  - Noise, vibration and harshness measurement

**Engine Combustion, Performance and Emissions Development**

- Gas and gasoline engines
  - Combustion development and optimization
  - Fuel mixing and combustion modeling
  - Ignition system development
  - Controls strategy for emissions and performance
  - Emissions development and calibration for both steady-state and transient operation
  - Gas composition blending for performance and emissions
  - Field site testing
- Diesel Engines
  - Combustion development and optimization
  - Fuel injection system and strategy development
  - Controls strategy for emissions and performance
  - Emissions development and calibration for both steady-state and transient operation
  - NVH calibration consideration

- Competitive engine benchmarking
  - Testing of new engine technologies
  - Detailed engine performance and emissions data
  - Controls strategies
  - Thorough design evaluation
  - Detailed component measurement
- Gas and large engine development
  - Engine development for production and research
  - Full diesel-to-gas conversions
  - Engine modeling and simulation
  - Combustion system development and optimization
  - Ignition system evaluation and development
  - Control system design, development and procurement
  - Injector testing, design and development
  - Emissions development and calibration for transient and steady-state operation
  - Mixing and combustion modeling
  - Gas composition blending and testing for performance and emissions effects
  - Durability testing over prescribed cycles
  - Remote data logging for field tests
  - Field-site testing
  - Locomotive, marine and mine engine emission characterization
- Spark ignition engines
  - Air-cooled engine development
  - Combustion analysis
  - Component design and testing
  - Cycle simulation
  - Durability testing
  - Emissions development
  - Engine benchmarking
  - Engine management system development
  - Fuel economy improvement
  - Friction measurement
  - Injectors and fuel spray characterization
  - Low-temperature testing
  - Real-time oil consumption measurement
  - Spark plug testing
  - Valve recession control
- Engine component database
  - Concept comparison to production engines and components
  - Design benchmarking database
- Detailed layout and CAD modeling
- Full engine and system modeling
- Design program structuring and management
- Design for low NVH
- Engine design analysis
  - Engine performance simulation, thermodynamic and fluid modeling
  - 1D cycle simulation
  - 3D combustion and induction modeling
  - Injection modeling
  - Fuel system simulation
  - Cooling and lubrication system modeling
- Engine structural analysis
  - Bolted joint calculations
  - Major engine component FEA
  - Fatigue analysis
  - NVH modeling
  - Geartrain structural analysis
- Engine dynamics modeling
  - Crankshaft torsion and bending analysis
  - Crank train dynamics modeling
  - Kinematic valvetrain analysis
  - Valvetrain dynamics modeling
  - Geartrain dynamics modeling
- Engine mechanical development
  - Durability testing
    - Test cycle definition
    - Production validation plan definition
    - Engine testing
  - Component thermal measurement
    - Cylinder heads
    - Pistons
    - Valves/valve seats
    - Cylinder bores
    - Exhaust manifolds
  - Mechanical system testing
    - Valvetrain dynamics testing
    - Component strain measurement
    - Real-time oil consumption testing
    - Real-time corrosion testing
  - Component rig testing
    - Cylinder head hydraulic fatigue
    - Cylinder block hydraulic fatigue
    - Connecting rod fatigue
    - Rocker arm fatigue
  - Field test support
  - Failure analysis and problem solving design reviews
  - NVH testing and development

### **Engine Design and Analysis**

- Engine design
  - Concept design
    - Engine design sizing and packaging studies
    - Concept layout and modeling
    - Costing analysis
  - Concept feasibility studies



## **Capabilities of the Fuels and Lubricants Research Division**

[flrd.swri.org](http://flrd.swri.org)

The Fuels and Lubricants Research Division is internationally known for its fuels and lubricants research activities and continues to uphold the longstanding tradition of quality and client response, started more than 55 years ago. The Institute helps clients get automotive products to the market and keep them there in response to regulation and competition. A broad range of services is available for product research, product development and product qualification of automotive components and automotive fluids for on-road, off-road, rail and water-borne transportation systems as well as recreational vehicles and stationary power equipment.

The Fuels and Lubricants Research Division is certified to ISO 9001:2000 “Quality Management Systems - Requirements,” accredited to ISO/IEC 17025:2005 “General Requirements for the Competence of Testing and Calibration Laboratories” and certified to ISO 14001:2004 “Environmental Management Systems.” The division has also achieved Ford Tier 1 status for providing engineering services and has received the Ford Q1 Quality Award.

In conjunction with these divisional quality system accomplishments, the Petroleum Products Research Department is a Nuclear Procurement Issues Committee (NUPIC)-approved laboratory and the Fuels and Lubricants Research Division has maintained its status as an American Chemistry Council (ACC)-approved laboratory.

Lee J. Grant, *Vice President*  
 Larry M. Bendele, *Institute Engineer*  
 Robert L. Mason, *Institute Analyst*

The Fuels and Lubricants Research Division is currently organized into four departments:

### **Fuels and Lubricants Research**

- Heavy duty engine oil evaluations
- Passenger car engine oil evaluations
- International lubricant testing (ACEA and JASO engine procedures and laboratory tests)
- Specialized lubricant evaluations

### **Fuels and Driveline Lubricants**

- Fleet and field evaluations
- Fuel performance evaluations
- Specialty and driveline fluid evaluations
- Off-highway hydraulics and drivetrain testing

### **Fuels and Lubricants Technology**

- Fluids filtration and handling research
- Fuels, lubricants and fluids applications
- Filtration and fine particle technology
- Fuel systems and contamination research
- TARDEC

### **Petroleum Products Research**

- Fuel analysis laboratory
- Fuel conformance
- Lubricant analysis laboratory

## API CJ-4 (PC-10) Performance Category

### Summary

- Roller follower wear
- Mack T-11, Mack T-12
- Caterpillar 1-N, C13
- Cummins ISM, ISB
- NAVISTAR engine oil aeration
- Sequence IIIF or IIIG

## API CI-4 Plus, CI-4 Performance Category Summary

- Roller follower wear
- Mack T-8, Mack T-10, Mack T-11
- Cummins M-11 EGR
- Caterpillar 1M-PC, 1P
- Caterpillar 1-N, 1-K, 1-R
- NAVISTAR engine oil aeration
- Sequence IIIF
- Engine oil aeration test

## ACEA Engine Procedures

- Low-temperature sludge (ASTM D 6593-00)
- Mercedes-Benz M111 black sludge (CEC L-53-T-95)
- Mitsubishi 4D34T4 valvetrain wear (JASO M354:2006)
- Nissan TD 25 detergency (JASO M336:1998)
- Peugeot DV4TD medium temperature dispersivity (CEC L-93-04)
- Peugeot TU3M valvetrain scuffing wear (CEC L-38-A-94)
- Peugeot TU5 JP+L4 high-temperature
- Volkswagen T4 viscosity increase, TBN depletion and piston cleanliness (VW PV 1449)
- Volkswagen turbocharged DI diesel piston cleanliness and ring sticking (CEC L-78-T-99)

## ACEA Laboratory Tests

- Corrosion (ASTM D 6594)
- Evaporative loss (CEC L-40-A-93)
- Foaming tendency (ASTM D 892)
- High-temperature foaming tendency (ASTM D 6082)
- Oil/elastomer compatibility (CEC L-39-T-96)
- Oxidation (CEC L-85-T-99)
- Shear stability (CEC L-15-A-93)
- Sulfated ash (ASTM D 874)
- Viscosity at high-temperature and high-shear rate (CEC L-36-A-97)
- Viscometric properties test (SAE J300)

## ILSAC GF-4 Performance Category

- Ball rust test (ASTM D 6557)
- Sequence IIIG, IIIGA
- Sequence IVA
- Sequence VG
- Sequence VIB
- Sequence VIII

## ILSAC GF-3 Performance Category

- Ball rust test (ASTM D 6557)
- Sequence IIIF
- Sequence IVA
- Sequence VE, VG
- Sequence VIB
- Sequence VIII

## Small Engine and Leisure Marine Lubricant Evaluations

- ASTM-TC test sequences
- JASO standards
- NMMA TC-W3™
- Small air-cooled engines

## Fleet and Field Evaluation Services

- Air conditioning systems
- Automatic transmission fluids
- Axle lubricants
- Brakes
- Coolants
- Crankcase oils
- Electronics and electrical systems
- Engines
- Evaporative emissions
- Exhaust systems
- Fuels, Fuel economy
- Tires, Tire testing
- Commercial, private, captive, dedicated fleet tests of cars, trucks, buses
- Mileage accumulation dynamometer services
- Driveability
- Performance
- Durability
- Tractor field tests
- Environmental chamber services
- Port fuel injector (PFI) deposits
- Intake valve deposits
- Combustion chamber deposits
- Octane number (ORI) requirement measurement
- Fuel blending facility – 6,000 square-foot facility, seven stainless steel tanks, temperature controlled storage, 4,700-gallon capacity

- SAE J1321 Class 8 truck fuel economy
- Coolant performance testing
- Cold temperature effects
- Vehicle durability
- Fuel development programs
- Component evaluations
- Vehicle performance evaluations
- Mobile data acquisition
- Valve sticking evaluations

## Fleet Testing of Engine Oil Performance

- Reduction of exhaust after-treatment deactivation
  - Includes diesel lean NO<sub>x</sub> traps and particulate filters
- E85 interaction with engine oil
- Oil consumption testing
- Effect of start/stop with hybrids on engine oil

- Acceleration tests
- Running compression
- Prevention of smoke in high mileage engines
- Crankcase oil in direct injection engines
- Effect of cylinder deactivation

## Specialty and Driveline Fluids Evaluations

- Gear oil
- Hydraulic fluids
- Automotive driveline components
- Automatic transmission fluids, cycling, oxidation performance
- Tractor hydraulic fluids and tractor testing
- Specialized test programs
- Specialized evaluations
- Vehicle, FZG gear distress testing
- Friction and wear performance
- Construction equipment and components

## Fluids Filtration and Handling Research

- Heat transfer and process equipment
- Fluid mechanics and hydraulic systems
- Fluid filtration and cleanliness
- Fuel logistics
- Advanced methods of fuel property measurement
- Chemometric methods of analysis
- Sensors and instrumentation development
- Particle counting
- Fuels filtration
- Lubrication filtration
- Soot contamination
- Debris analysis
- Test method development
- Field service
- Fuel properties, renewable fuels, fuel stability
- Analytical laboratory
- Fuel storage
- Distillate fuel peroxidation

## Fuels, Lubricants and Fluids Applications

- Investigations of fuel/lubricant/engine interactions, exhaust emissions
- Fuel and fluid flammability hazard assessments
- Diesel engine dynamometer evaluations, alternative fuels utilization, JP-8 use in diesel equipment, exhaust emissions
- Fuel injection system bench tests
- Tribology, engine dynamometer evaluations

- Fuel combustion, flammability, alternative fuels
- Additives, greases and specialty fluids
- Bench test development, fuel system materials compatibility
- Field and fleet evaluations
- Fuels/hardware interactions and test rig design
- Combustion kinetics
- Aviation fuels and thermal stability
- Turbine combustor facility

## Filtration and Fine Particle Technology

- Filtration and environmental testing
- Real-time engine wear and measurement
- Real-time oil consumption measurement
- Test system development and component testing
- Air filtration facility
- Air filter test stand design and fabrication

## Fuel Systems and Contamination Research

- Contaminant characterization
- Accelerated life testing or key-life testing
- Material compatibility
- Modeling and simulation
- Test procedure development
- Lubricity, friction and wear
- Environmental evaluation
- Filtration
- Emissions and safety issues
- Component and systems development

## Fuel Analysis Laboratory

- Gasoline fuels analyses
  - Research and motor octane numbers
  - Benzene content
  - Hydrocarbon typing
  - Distillations
  - Oxygenate content
  - Sulfur and other elemental contents
  - Vapor pressure; V/L ratio
  - Unwashed and washed gums
  - Oxidation stability
  - Sulfur speciation
  - Density
- Diesel fuel analyses
  - Biodiesel specification testing
  - Cetane numbers
  - Hydrocarbon typing
  - Distillations
  - Density
  - Water and sediment
  - Flash point
  - Heat of combustion
  - Sulfur content
  - Carbon residue
  - Cold filter plugging point
  - Low-temperature flow test
  - Cloud point
  - Pour point
  - Copper strip corrosion
  - Aniline point
  - Hydrogen content
  - Particulate contamination
  - Carbon, hydrogen, and nitrogen content
  - Color
  - Poly-nuclear aromatic content
  - Filter blocking tendency
- Laboratory instrumentation and equipment
  - Atomic absorption spectroscopy
  - Automatic distillation units
  - Density meters
  - Elemental analyzers, nitrogen, carbon, hydrogen and sulfur
  - Monochromatic wavelength dispersive X-ray fluorescence (MWDXRF)
  - Energy-dispersive X-ray fluorescence (XRF) analyzer
  - Wavelength-dispersive X-ray analyzers
  - Fourier transform infrared (FTIR)
  - Gas chromatographs with various detectors
  - High-performance liquid chromatographs with various detectors

- Octane and cetane test engines
- Ultraviolet-visible spectrometer
- Thermal analyzers, TGA and DSC
- Supercritical fluid chromatograph
- Broadband NMR
- Gas chromatographs with mass selective detectors (GCMS)
- Vacuum distillation

## Fuel Conformance

- Field sampling services of fuels at service stations and dealerships
- Custom-designed programs
- Sample kits sent to terminals/dealerships
- Independent contractors to pick up/ship samples for testing
- Fuel analysis
- Processing of as many as 350 samples/day

## Lubricant Analysis Laboratory

- Viscosity
- Elemental analysis
- Oxidation
- Nitration
- Additive depletion
- Base number
- Fuel dilution
- Water dilution
- Antifreeze dilution
- Soot (TGA)

## Other Services Offered by Laboratory

- Crankcase, hydraulic fluid, gear and two-cycle oil evaluations
- Automatic transmission fluids analysis and qualification (DEXRON®, MERCON®, and Allison Transmission-approved laboratory)
- Coordinating laboratory for Ford MERCON® and Allison Transmissions
- Antifreeze coolant analysis
- Oil additive (boost and blend)
- Oil filter evaluation, using SAE J905 fuel filter test stand, SwRI-built SAE HS806 test stand, and multi-pass ISO 4548-12 test stand and various ISO standards
- High- and low-temperature viscosities
- NOACK evaporation
- Elemental content
- Thermal stability
- Oxidation, nitration, contamination
- Foam, miscibility, compatibility

## Other Services Offered by Laboratory (continued)

- Fuel dilution
- Corrosion bench test
- Gelation index
- TEOST MHT-4 and TEOST 33C
- European bench tests
- Elastomer compatibility
- Thermal analysis, TGA and DSC
- Oxidation, rust
- Copper corrosion
- Shear stability
- Coefficient of friction
- Foam, miscibility, compatibility
- Seal compatibility
- Extreme pressure and wear
- Thermal stability
- Microwave digestion on non-traditional samples
- Nuclear power plant diesel fuel and lubricant quality assurance and analysis
- Aviation fuel testing
- Lubricity and fuel screener test capabilities
- Trace pollutants analysis
- Bench testing for injector plugging and valve deposit tendencies

# Automotive Engineering

## – Facilities –

oae.swri.org

### SwRI Engine and Vehicle Emissions Testing Facilities

- Twin-roll hydrokinetic dyno, 4,875-pound capacity, 50 HP, 2 PM tunnels
- Twin-roll hydrokinetic dyno, 4,875/7,250-pound capacity, 50 HP, FWD and RWD: 10°F to 120°F
- LD 48-inch electric dyno, 12,000-pound capacity, 50 HP, ULEV
- MD 48-inch electric dyno, 15,000-pound capacity, 200 HP, SULEV
- 14 HD transient and steady-state emission test cells
- Both on-highway and non-road engines
- Diesel, gasoline, LPG, NG and other alternative fuels
- Conforms with all certification requirements
- Developing 2007/2010 facilities and procedures (EPA Part 1065)
- Advanced data acquisition and test cell control computer systems
- 31 highly instrumented developmental test cells

### Heavy-Duty Vehicle Chassis Testing

- All-electric dyno, 48-inch Rolls
- Inertia to 120,000 lbs. for tandem-axle vehicles
- Transient or steady-state tests
- Drive cycle or route mode
- Analog and CAN data acquisition
- Assess emission control devices
- Hybrid-electric vehicle testing
- In-use emission studies
- Thermal management studies

### Fleet and Fuel Capabilities

- On-board data acquisition
  - High-speed and long-term data-loggers
  - Monitoring vehicle data bus information
- Highly trained vehicle technicians
- Portable emissions measurement system
- 20 mileage accumulation dynamometers
- Towing dynamometer
- SwRI oval track
- Grades up to 11% in the Texas Hill Country
- Cold box (-18F°)

### Mileage Accumulation Dynamometers (MADs)

- 20 MADs
- Powertrain durability
- Exhaust aftertreatment evaluations
- PC-based data logging capability

### Engine Dynamometer Cold Testing

- Coldbox #1
  - 3.5 m × 2.9 m × 2.3 m internal dimensions
  - Fired diesel and motored gasoline/diesel engines
  - Fired: 300 kW@6000 rpm, motored: 225 kW@6000 rpm
  - Cooling capacity: 27°C to -46°C in about 8 hrs
- Coldbox #2
  - 3.3 m × 2.7 m × 2.1 m internal dimensions
  - Fired/motored gasoline/diesel engines
  - Fired: 300 kW@5000 rpm, motored: 75 kW@3400 rpm
  - Cooling capacity: 27°C to -40°C in about 8 hrs
  - Note: Enclosures are not capable of altitude simulation
- Cold-start chamber
  - -30°C
  - Unloaded or loaded starts and warmups

### Temperature-Controlled Vehicle Test Chambers

- Low-temperature chamber
  - Two-vehicle capacity
  - Minimum temperature -28°C
  - Startability
  - Valve sticking
- Driveability test chamber
  - Located at campus track
  - Minimum temperature 4°C

### Temperature-Controlled Emissions Enclosure

- Range of -10°C to 50°C while vehicle is running
- Equipped with small-roll dynamometers

### Additional Cold Testing Capabilities

- Envirotronics system
  - 30 HP of refrigeration at -40°C
  - 36 kW of heating capacity
  - 4500 cfm air flow
  - 10 cfm dry air purge (humidity removal) system
  - Temperature range -68°C to 177°C
  - Temperature control +/-1.1°C
  - Transition rates -40°C to 65°C in 180 minutes with 600 pounds
  - 65°C to -45°C in 180 minutes with 600 pounds

### Heavy-Duty Engine Oils (HDEO)

- 38 engine-dynamometer test stands
- Dynamometers range from 175hp to 1,200hp
- Specs: ASTM, CEC & Proprietary Testing

### Passenger Car Motor Oils (PCMO)

- 51 engine-dynamometer test stands
- Dynamometers range from 30hp to 500hp
- 2 Cold box testing facilities (-50°F to 120°F)
- Specs: ASTM, CEC, JAMA and proprietary testing

### Small Engine & Leisure Marine

- 8 engine-dynamometer test stands (10-30hp)
- 7 water tanks (6=5'x5'x9', 1=8'x9'x21')
- 23,000-gallon test tank
- Specs: ASTM, CEC, JASO, ISO, NMMA and proprietary testing

## Offices



Beijing, China



San Antonio, Texas



Ann Arbor, Michigan

## China and Ann Arbor Facilities

### Beijing

[chinaoffice.swri.org](http://chinaoffice.swri.org)

In 2003, Southwest Research Institute established a liaison office in Beijing, China, to facilitate business opportunities stemming from China's rapidly expanding economy, business climate, transportation technology and energy needs. The staff in the Beijing office coordinate activities between SwRI and clients in China and surrounding areas.

**Robert Burrahm, PMP**, Chief Representative  
Southwest Research Institute  
Unit 1304, Tower 2, Beijing Landmark Towers  
8 North Dongsanhuan Road  
Chaoyang District  
P.R. China  
Tel: (210) 522-3064  
86-10-6590-6391, ext. 804  
Fax: 86-10-6590-6392  
[rburrahm@swri.org](mailto:rburrahm@swri.org)

**Ximin Shi**, Senior Business Development Manager

- Engine Design and Development
  - Engine Emissions Development
  - Drivetrain Design and Development
  - Hybrid Vehicle Systems Engineering
  - Powertrain Controls
- Tel: 86-10-6590-6391, ext. 803

**Fiona Zhang**, Senior Account Manager

- Fuel and Lubricant Testing
  - Fuel and Lubricant Test Stands
  - FOCAS & USGR Test Systems
  - Emissions Systems Development
- Tel: 86-10-6590-6391, ext. 806

**Jinwu Li**, Senior Account Manager, Business Development

- Oil and Gas Exploration and Production Operations
  - Pipeline Inspections and Useful Life Determination
  - LNG Terminal and Distribution Facilities
  - Gas, Liquid and Petroleum Product Pipelines
  - Refinery and Petrochemical Operations
  - Engineering Structural Integrity and Reliability
- Tel: 86-10-6590-6391, ext. 805

### Ann Arbor

[annarbor.swri.org](http://annarbor.swri.org)

The Ann Arbor, Michigan office, established in the spring of 2005, offers technical and program support to clients located in southeast Michigan, and is an extension of Southwest Research Institute in San Antonio, Texas. The Ann Arbor office houses several SwRI engineers experienced in engine and vehicle control.

### Technical strengths include:

- Control algorithm development for engine, transmission and vehicle systems
- Software development for a variety of embedded systems
- Hardware development, both experimental and production intent
- System design, integration and test
- Controller calibration and automated mapping
- Algorithm and calibration optimization for improved performance, emissions and driveability
- Modeling for both real-time embedded models and laboratory simulations
- Hardware-in-the-loop simulation capabilities
- Signal processing and data analysis
- Rapid prototyping of powertrain and vehicle control systems
- OBD-II diagnostics
- Multiplexing and controller communications
- Hybrid vehicle control
- Benchmarking and reverse engineering of existing powertrain systems

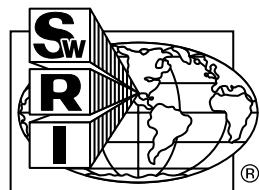
Contact:

**Scott Hotz**, Manager  
Southwest Research Institute  
2001 Commonwealth Boulevard  
Suite 202  
Ann Arbor, MI 48105  
(734) 786-3766 • Fax: (734) 913-0696  
[shotz@swri.org](mailto:shotz@swri.org)

**Bruce Bykowski**, Vice President  
Southwest Research Institute  
6220 Culebra Road  
San Antonio, TX 78238  
(210) 522-2937 • Fax: (210) 522-3950  
[bbykowski@swri.org](mailto:bbykowski@swri.org)



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***We welcome your inquiries.  
For additional information, please contact:***

Bruce Bykowski  
Vice President  
Engines, Emissions and Vehicle Research Division  
(210) 522-2937 • Fax: (210) 522-3950  
Email: [bbykowski@swri.org](mailto:bbykowski@swri.org)

Lee Grant  
Vice President  
Fuels and Lubricants Research Division  
(210) 522-5004 • Fax: (210) 684-7523  
E-mail: [lgrant@swri.org](mailto:lgrant@swri.org)

Southwest Research Institute  
6220 Culebra Road  
P.O. Drawer 28510  
San Antonio, TX 78228-0510 USA