

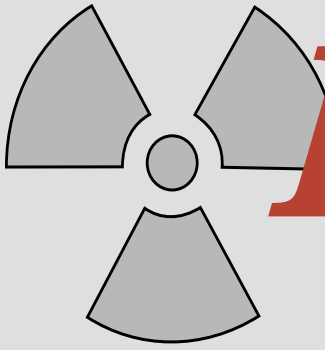
Radioactive Tracer Technology

**Measuring
Real-Time
Wear in
Operating
Engines**



Southwest Research Institute

San Antonio, Texas



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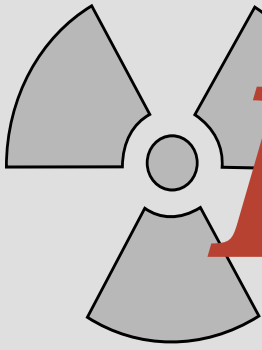
For 45 years, Southwest Research Institute (SwRI) has used radioactive tracer techniques to make highly accurate and sensitive real-time wear measurements in operating engines. These capabilities are particularly important in light of the harsh operating and environmental conditions imposed on today's high-performance engines, in which performance as well as low emissions levels increasingly depend on close-tolerance operation with minimal wear. Using sophisticated instrumentation, SwRI studies real-time wear, detecting wear and wear rate changes instantly. Advantages of radioactive tracer measurement techniques include:

- Cost-effective tests
- Repeatable measurements
- Real-time wear data
- Meaningful results for short tests
- Easily measured transients
- Identification of cause and effect relationships
- Association of wear with specific design parameters, fuel and lubricant characteristics, and engine operating conditions

Two radioactive tracer techniques are typically used to measure internal combustion engine component wear: bulk activation and surface- or thin-layer activation (SLA/TLA). SwRI selects the appropriate method based on specific test objectives, component metallurgy, and configuration or site particulars.

The Institute measures wear as a function of lubricant and engine operation parameters using bulk-activated rings and connecting rod bearings in a test engine.

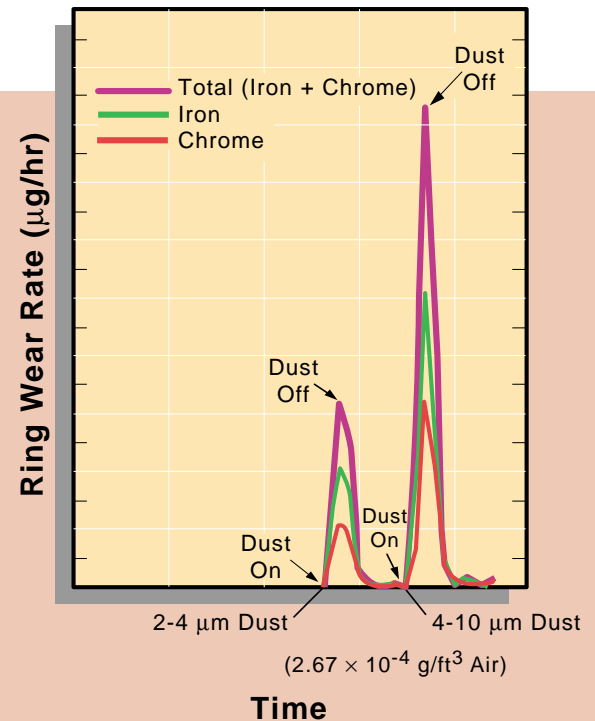
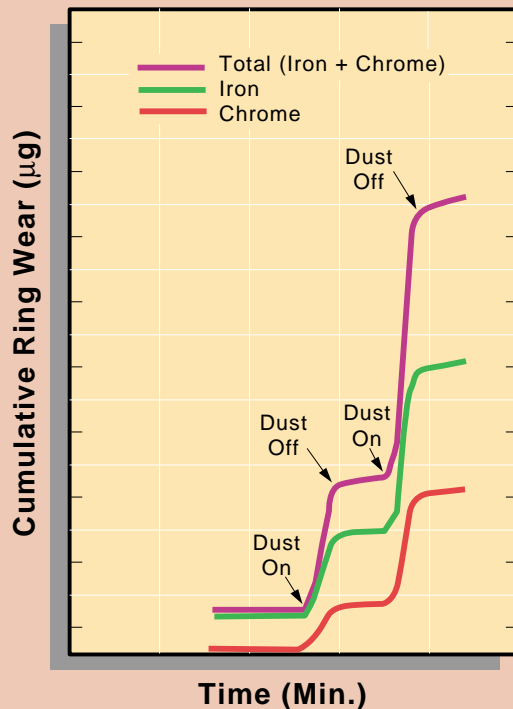
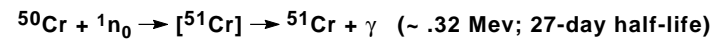
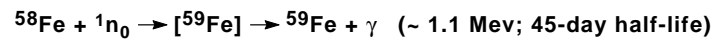
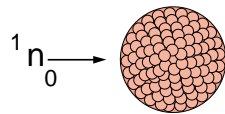
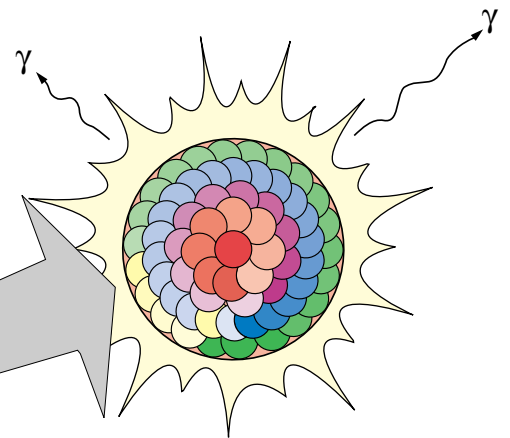




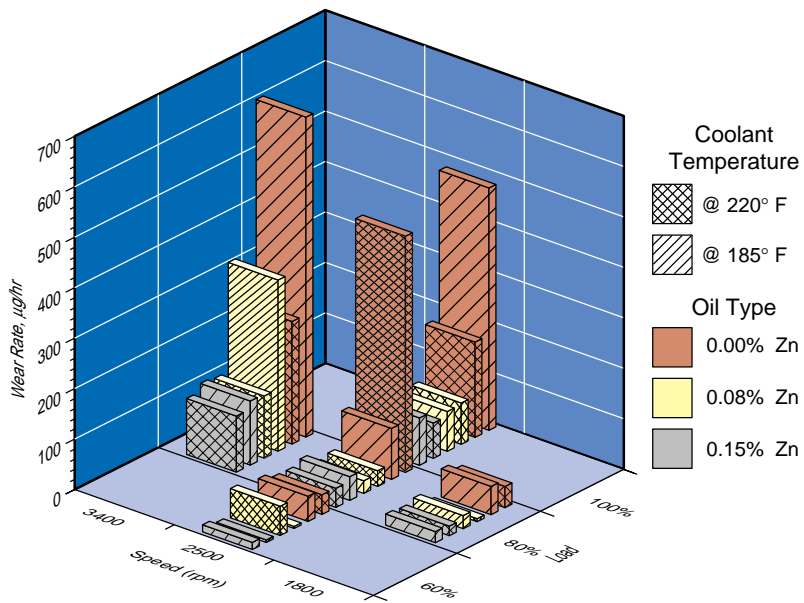
Bulk Activation

For bulk-activation testing, components are neutron (n) irradiated in a research reactor and installed in a test engine. As irradiated particles abrade from these components during engine operation, specific radionuclides serve as detectable tracers in the lubricant or cooling water. SwRI measures radiation from these particles using a gamma ray spectrometer; the radiation detected is proportional to the mass of the abraded material in the circulating fluids. Multiple radionuclides can be measured simultaneously, allowing wear from multiple parts or surfaces to be measured during a single test.

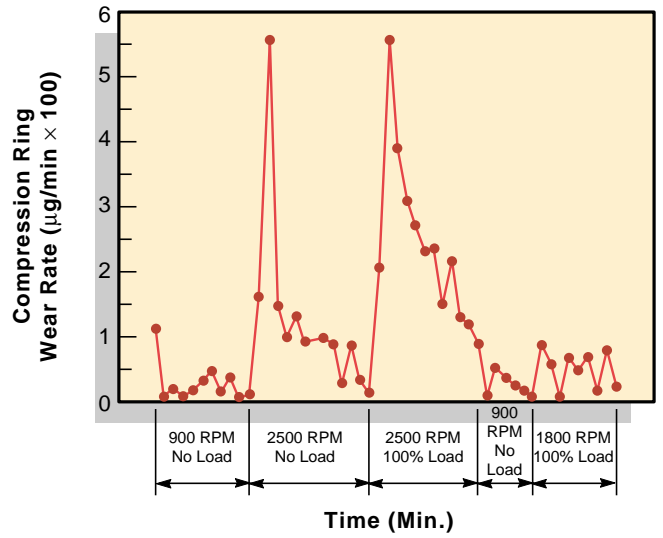
To measure wear in operating engines, specific components are first neutron activated in a reactor. During wear testing, abraded material is measured using the resulting traceable radionuclides.



Institute staff members study the impact of dust ingestion on engine wear using upstream dust particle sizing and radioactive tracer analysis.

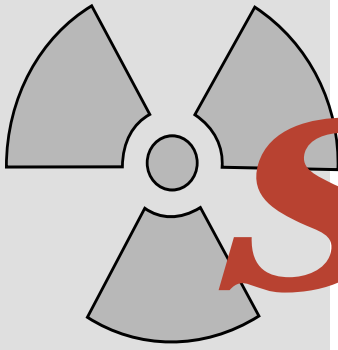


SwRI maps natural gas engine wear as a function of speed, load, coolant temperature, and oil type.



Using bulk radioactive tracer methods, SwRI measures transient piston ring wear associated with speed and load changes.

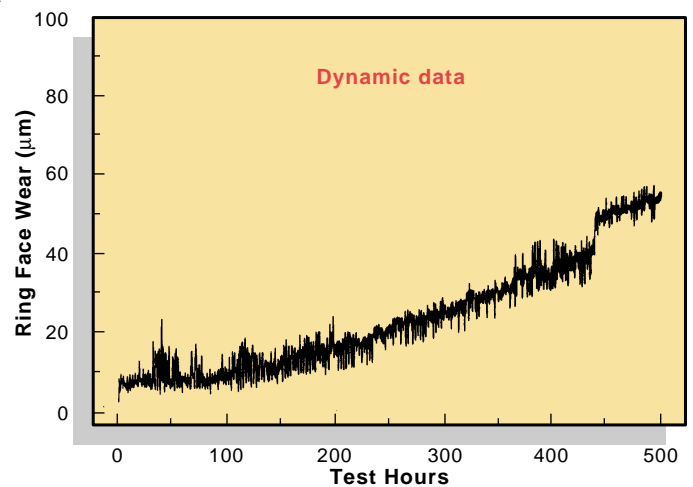




Surface- or Thin-Layer Activation

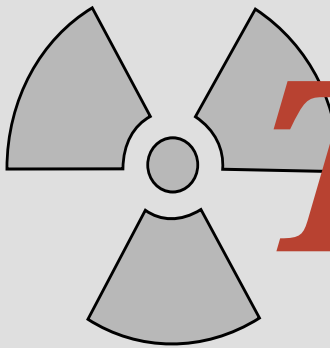
Using SLA/TLA techniques, components are bombarded with a high-energy beam of charged particles to activate a thin layer of atoms on the component surface. Wear is measured by monitoring a decrease in the component's radioactivity or an increase in the radioactivity of debris collecting in a fluid filter.

Using SLA, SwRI measures in situ piston ring wear as a function of liner surface treatment in a diesel engine.



Radioactive tracer wear testing can be applied to virtually any metal part that provides suitable radionuclides when irradiated. In addition to engine components, transmission gears and hydraulic pump parts are ideal candidates.



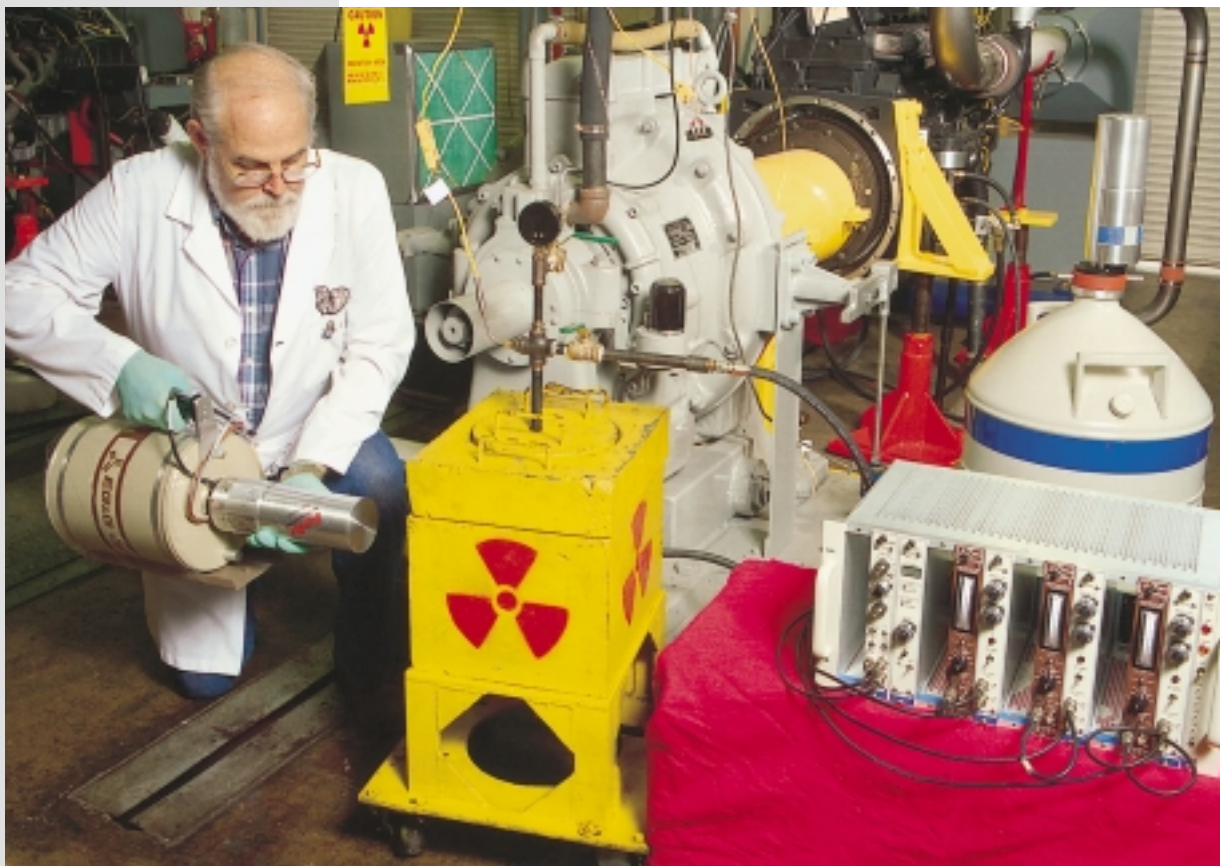


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he Institute's radioactive tracer techniques provide cost-effective, accurate, real-time data, detecting minute wear changes without disassembly and physical inspection, to study component wear under transient and steady-state conditions.

Past SwRI radioactive tracer measurement projects have included:

- ❑ Measuring piston ring wear associated with changes in engine speed, load, and operating temperature; fuel and lubricant quality and type; and internal and external contamination
- ❑ Measuring fuel injector wear associated with component metallurgy, fuel quality, and contaminant level
- ❑ Evaluating diesel engine cylinder liner wear correlating to liner design, material, and lubrication
- ❑ Investigating engine wear sensitivity to fuel, lube oil, and air filtration
- ❑ Measuring engine wear associated with dust contamination to determine relationships between component wear, particle size, and filtration level
- ❑ Studying filter performance and filter test procedures using irradiated standardized test dusts
- ❑ Comparing component wear for an engine operating alternately on natural gas and gasoline



Institute engineers and scientists developed a flow-through radioactive tracer detector system. To determine wear data, the detector is coupled to a high-speed multichannel analyzer to count and process radiation from radionuclide tracers.



Southwest Research Institute is an independent, nonprofit, applied engineering and physical sciences research and development organization with 13 technical divisions using multi-disciplinary approaches to problem solving. The Institute occupies 1,200 acres and provides nearly two million square feet of laboratories, test facilities, workshops, and offices for more than 2,500 employees who perform contract work for industry and government.

We welcome your inquiries.

For more information, please contact:



**Martin B. Treuhaft, Manager
Filtration and Fine Particle Technology
Engine and Vehicle Research Division
Southwest Research Institute
6220 Culebra Road • P.O. Drawer 28510
San Antonio, Texas 78228-0510
(210) 522-2626 • Fax (210) 522-5720
E-mail: mtreuhaft@swri.org
Web Site: <http://www.swri.org>**