



Trans Forum

News From Argonne's Transportation Technology R&D Center



Page 2

■ VIEWPOINT

Energy Secretary Dedicates Argonne's Transportation Center

U.S. Department of Energy Secretary Bill Richardson visited the Laboratory in September to address Argonne and DOE-Chicago employees and dedicate the new Transportation Technology Research and Development Center. During his address, Richardson applauded Argonne's achievements in transportation research and pledged continued support by DOE. *Page 2*

■ RESEARCH REVIEW

New Technology Promises Cleaner Diesels

Argonne finds a way to reduce both particulate and NO_x emissions from diesel engines

Working with several industrial partners, Argonne discovered a process in which changing oxygen levels and engine operating conditions improves combustion, which results in simultaneously lowering particulate and NO_x emissions. *Page 5*

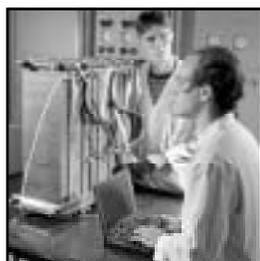


Page 5

Measuring How Fuel Cells Stack Up

New facility permits direct comparison of different technologies

A new laboratory at Argonne offers a "standard yardstick" for measuring new fuel cell technologies for vehicles. Equipped with extensive and specialized hardware and computing power, the Fuel Cell Test Facility provides a standard test environment for benchmarking new fuel cell stacks and systems. *Page 6*



Page 6

■ LOOKING DOWN THE ROAD *Page 7*

■ FASTRAX *Page 7*

■ PARTNERING WITH ARGONNE *Page 8*



Energy Secretary Dedicates Argonne's Transportation Center



Secretary Richardson shares a laugh with George Fenske and Ali Erdemir of Argonne's Energy Technology Division at the R&D 100 Awards ceremony. The two were honored by R&D Magazine for their work on near-frictionless carbon coatings (see TransForum Vol. 1, No. 1, p. 6).



"EMD and Argonne have developed a new diesel engine technology at a leading edge, world-class level. We're excited about taking on the next challenge — emissions control of this engine. We're counting on tapping into the expertise of the national laboratories to make emissions reductions on American railroads a success."
Kelly Jones, Chief Engine Development Engineer, Electro-Motive Division, GM.



"I have worked very closely with Argonne for over 10 years... The breadth and depth of the research capabilities here at Argonne are remarkable — from innovations that improve conventional vehicles and engines to advanced technologies such as fuel cells and energy storage devices, and hybrid vehicles."
Pandit Patil, Director of DOE's Office of Advanced Automotive Technologies.



“This device can help clean our air while increasing fuel efficiency and improving engine performance in our cars, trucks, and locomotives.” Secretary Richardson with Interim Laboratory Director Frank Fradin announcing new clean diesel technology.

Richardson and Carlos Buitrago of Argonne examine a vehicle entered by students from the University of Illinois – Chicago in last summer’s Ethanol Vehicle Challenge.



“I think I remember how to drive a stick.” Secretary Richardson takes a spin in the University of Wisconsin – Madison FutureCar.



Hundreds of enthusiastic Argonne employees joined DOE Secretary Bill Richardson on a warm September morning to dedicate Argonne's Transportation Technology Research and Development Center (TTRDC).

The ceremony began with a short address by Larry Johnson, who heads the TTRDC. Johnson described the Center as a cooperative effort among staff of ten different divisions at Argonne to apply their specialized science and engineering knowledge to solve the nation's transportation problems. Interim Laboratory Director Frank Fradin introduced the new Secretary of Energy.

Secretary Richardson was greeted with a warm response from the Argonne crowd and he responded in kind. He affirmed DOE's continuing support for the national laboratories, saying "Argonne has an impressive record of transportation research... We at the Department of Energy look to Argonne to continue to use their creativity to find solutions to the nation's transportation and environmental problems... I salute you as Secretary of Energy. You should be proud of what you do. We don't say thank you enough. Thank you — you are heroes."

The Secretary announced a new clean diesel technology developed by Argonne and several industrial partners. "This research is an excellent example of government-industry research, and the results are the first of many we expect from this transportation technology center." The new technique represents a breakthrough for diesel engines, the most efficient internal combustion engines, that will allow them to operate more cleanly and efficiently (see story on page 5). The dedication ceremony included a short video that illustrated how the new technology controls fuel and oxygen levels in diesel engines, reducing both particulate and NO_x emissions. The device has been demonstrated in locomotives, but it also holds great promise for cars and heavy vehicles.

Representatives of two of Argonne's three industrial partners, who worked with Argonne staff to develop the clean diesel technology, also addressed the crowd: Kelly Jones, representing the Electro-Motive Division of General Motors, and Kevin Callaghan of Compact Membrane Systems. Jones stated that EMD's partnership with Argonne is "already a success story... since the new engine research facility was dedicated two years ago, we have increased the power output of our diesel engine



"I take great pleasure today in dedicating Argonne's Transportation Technology Research and Development Center as yet another part of this administration's continuing fulfillment of the President's vision for technology leadership." DOE Secretary Bill Richardson waves the checkered flag to dedicate Argonne's TTRDC.

by 50% — from 4,000 to 6,000 horsepower." The 6,000-horsepower version of the single-cylinder research engine that EMD worked on with Argonne is now operating on American railroads.

Callaghan discussed how O₂- and N₂-enriched air improves engine performance, making diesel engines more productive, durable, and economical. He credited Argonne and EMD with laying the foundation for commercialization of the new technology.

Pandit Patil, Director of DOE's Office of Advanced Automotive Technologies, praised Argonne's "careful stewardship of national goals." He stated that without Argonne and its transportation staff "the progress we've made today would not have been forthcoming. Your contribution has made this partnership a success."

Those present cheered as Secretary Richardson waved a checkered flag to officially open the Center — where scientists and engineers from government and industry will build on two decades of transportation research to solve the transportation challenges of the future.



New Technology Promises Cleaner Diesels

Argonne finds a way to reduce both particulate and NO_x emissions from diesel engines

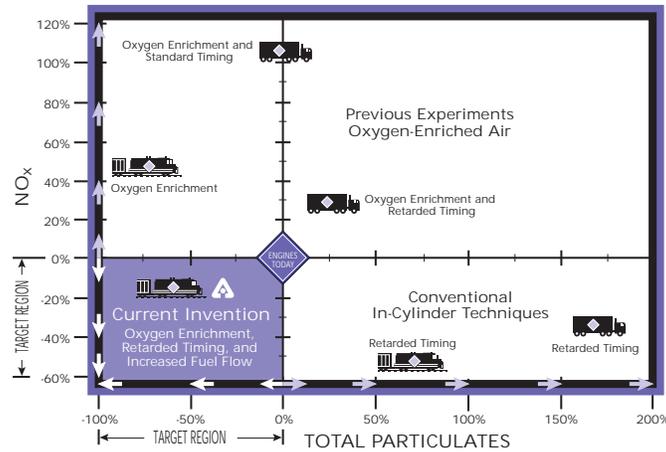
During his visit, Secretary of Energy Bill Richardson announced an energy and environmental breakthrough by Argonne that will eliminate two traditional roadblocks to clean and efficient operation of diesel engines.

Diesel engines are the most efficient internal combustion engines, but the smoke and particulate emissions they generate have prevented them from being considered a “clean” technology. Researchers have known since the ‘70s that when oxygen-rich air is fed into an engine, the higher oxygen ratio allows fuel to burn more completely, which reduces emissions of the incomplete combustion products and increases power. But, until recently, the reduction in particulates was accompanied by an increase in oxides of nitrogen (NO_x) emissions because of the higher combustion temperatures. Lack of a compact onboard oxygen source also prevented the use of oxygen enrichment for practical applications. With this breakthrough, Argonne seems to have overcome both challenges.

Working with several industrial partners — Electro-Motive Division of General Motors (EMD), Compact Membrane Systems (CMS), and the Association of American Railroads — Argonne found that simultaneously changing oxygen levels and engine operating conditions improves the combustion process, which results in significantly lower particulate and NO_x emissions.

The breakthrough came when Argonne researchers modestly increased the oxygen in the engine air supply (by 23-25% by volume), retarded the fuel injection timing, and increased the rate of fuel flow to the engine. Using this combination of conditions, Argonne was able to reduce particulate emissions by 60%, reduce NO_x emissions by 15%, and increase gross engine power by 18%. The breakthrough technology is also expected to be more cost-effective than alternative exhaust control systems currently being developed.

To address the second challenge, lack of a compact onboard oxygen source, Argonne and CMS developed a low-cost permeable membrane to separate ambient air into oxygen-rich and nitrogen-rich air before it enters the engine. The membrane works by a process called solution diffusion, in which



pressurized ambient air is passed across tubes coated with a special polymer that separates the air into two streams: one rich in oxygen and the other in nitrogen. The oxygen-rich air is directed to the engine to optimize combustion. Argonne is working to minimize the size and power requirements for the membrane. The current version of the membrane is 10 times shorter and uses

60% less power than its predecessors. The goal is to develop a membrane about the size of a car’s air filter.



Membrane “chemical filter” separates air into oxygen-rich and nitrogen-rich streams. The oxygen-rich stream is supplied to the engine, where the extra oxygen improves combustion.

“This exciting, new clean diesel discovery is a major finding of Argonne’s Transportation Technology R&D Center,” said Secretary Richardson during the TTRDC dedication ceremonies. While further research is needed, this new strategy represents a major step in addressing air pollution associated with diesel engines. The first beneficiaries will be America’s railroads and the people who live and work near tracks and rail yards. Ultimately, when the technology is extended to truck and automobile engines, we will all benefit.

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Measuring How Fuel Cells Stack Up

New facility permits direct comparison of different technologies



Automotive-scale fuel cells, such as this 30-kW proton exchange membrane (PEM) stack, get a thorough examination at Argonne's Fuel Cell Test Facility.

A new laboratory at Argonne offers a “standard yardstick” for assessing the performance of new fuel cell technologies for vehicles. Equipped with extensive and specialized hardware and computing power, the Fuel Cell Test Facility provides a standard test environment for benchmarking new fuel cell stacks and systems.

The testing results can also help focus research, so development cycles can be shorter and cheaper. “It really lets you know where you stand, and where to focus future R&D,” says Pat Davis, a program manager in the Fuel Cells for Transportation Program of the U.S. Department of Energy’s (DOE’s) Office of Advanced Automotive Technologies, which sponsors the facility.

Fortunately, the facility is more accessible than a precise measurement standard kept under lock and key. While it was primarily built to help DOE assess products developed under its contracts, the facility is also available to automakers and developers of fuel cells and components for their own evaluations. “We want to encourage that to happen,” says Davis.

The complexity of fuel cell systems means that testing their performance is a challenge. Some developers of fuel cell stacks and other system components may not have the equipment

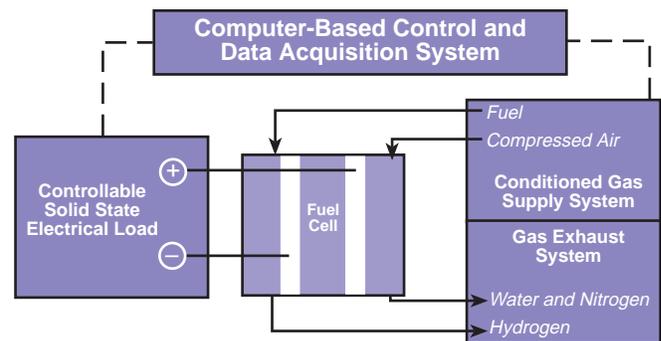
necessary to fully demonstrate how their units would work in a car. And when the issue becomes how well a fuel cell stack and various supporting systems work together, the testing problems get even more difficult.

With so many variables to consider, differences in testing strategies among developers can obscure comparisons and make technology decisions difficult.

The Fuel Cell Test Facility has been specifically designed for automotive power criteria. It is equipped primarily to test PEM fuel cells up to 50 kW, the size required for a passenger car. The brain of the facility is a computer-controlled electronic load system that can simulate the power demands of a vehicle.

The heart of the facility is a sophisticated gas management system that supplies air and fuel to the fuel cell with precise control of flow rate, pressure, temperature, and humidity. The fuel can be either pure hydrogen or a simulated reformat. (Reformat is the output gas of a device that produces hydrogen from other fuels, such as methanol, gasoline, or natural gas; see *TransForum*, Vol. 1, No. 1, p. 5.) Future testing is expected to include the evaluation of fully integrated fuel cell systems that incorporate their own fuel processing and air supply subsystems.

“The questions we want to answer are complex,” says DOE’s Pat Davis. “This benchmarking activity helps us measure how well we’re doing in meeting our technical goals for automotive fuel cells.”



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In the last *TransForum*, I issued an invitation to visit us here at Argonne to get a first-hand look at some of the innovative transportation research we're doing. Seems some pretty influential people were listening. This fall, we were privileged to host Bill Richardson, the new Secretary of the Department of Energy. Secretary Richardson had a very full agenda: he attended a reception for Argonne's R&D 100 winners; delivered an all-hands address to Laboratory and DOE-Chicago employees; visited the Advanced Photon Source, which provides the nation's most brilliant x-rays; toured Argonne's CAVE, a visualization research tool; participated in a demonstration of a DOE2000 computer networking research project that links some of the nation's most powerful microscopes and leading researchers over the internet; and, most important (as far as we're concerned), officially dedicated our Transportation Technology R&D Center.

During the dedication, Secretary Richardson had some encouraging words for those of us who work at the national laboratories. He assured us that this administration is committed to supporting scientific and technical research, and he applauded Argonne's work with industry to develop safer, cleaner, and more efficient transportation technologies.

But with these compliments, the Secretary also reminded us that the national laboratories need to do a better job of getting the word out. We need to show people how science and technology benefit society directly — and that's what this newsletter is all about. The research described in this issue and in every issue of *TransForum* — from intelligent transportation systems to sensors, fuel cells, advanced batteries, ethanol, and recycling is *directly* applicable to improving the quality of our lives. Once again, I invite you to call the contacts listed, write or fax us, or visit us here at the Laboratory to see what we can do for you.

Be sure to check out our Web site at <http://www.transportation.anl.gov> to read about our latest R&D 100 Award winner in the transportation area — near-frictionless carbon coatings.

Larry R. Johnson
Director



Chris Saricks of Argonne's Energy Systems Division was elected Chair of the AS-1 (Mobile Sources) Technical Committee for a 3-year term at the 91st annual meeting and exhibition of the Air and Waste Management Association in San Diego held June 14-18. He also co-chaired one paper and one poster session and assisted in the presentation of a co-authored paper with **Michael Wang**.

Shih-Yew Chen of Argonne's Environmental Assessment Division is currently chairing the DOE Transportation Risk Assessment Working Group. The mission of the group is to coordinate transportation risk assessment efforts across the DOE complex. The group will also prepare and issue a Transportation Risk Assessment Resource Handbook.

Argonne has been asked to take the lead in preparing a Materials Recycling Program Plan for DOE's Office of Advanced Transportation Technologies. **Ed Daniels**, who heads Argonne's Process Evaluation Section — where most of ANL's current recycling R&D programs are conducted — will lead the effort.

TTRDC staff from around the Laboratory participated in an exhibit at the Ford Motor Company on November 2-3 to showcase transportation research and technologies at DOE's national laboratories. **Shabbir Ahmed, George Fenske, Ron Kulak, Ed Plaskacz, Paul Raptis, Raj Sekar, Adrian Tentner, Dave Weber, Jim Willit, and Alan Wolsky** prepared exhibits and presentations for this invitation-only event.



Argonne is seeking industrial partners to develop advanced transportation technologies. The following types of working arrangements can be made:

- In a *reimbursable R&D agreement*, Argonne's industrial partner pays the full cost of the research performed. The company generally takes title to any inventions, and proprietary information and research results are kept confidential.
- In a *cost-shared R&D agreement*, Argonne and its industrial partner share the costs of research. The company may obtain rights to intellectual property developed by Argonne. Proprietary information is kept confidential, and research results may be protected from disclosure for up to five years.

■ *Licenses* for Argonne inventions and software may be granted to companies that wish to develop them into marketable products or processes. Licenses may also be part of other agreements.

■ *Personnel exchanges* and *technical assistance* projects can be arranged with Argonne for short-term or rapid-turnaround work.

For more information about working with Argonne, contact:

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