

# Rolling With Coal

*Transportation in the United States today is almost entirely fueled by petroleum products, for which the country is increasingly dependent on foreign suppliers. Some developers now suggest that U.S. railroads consider a return to domestic coal as fuel.*

By DIETRICK E. THOMSEN

**R**ailroads and coal went together for a long time. The first railroads were tramways in coal mines. The first railway in the world to use steam locomotives, England's Stockton and Darlington, was built to carry coal in the Tees River Valley. Coal was and is a major component of the traffic of many railroads, and for more than 100 years it was the major fuel for railroads. Railroads in the United States today still haul a lot of coal, but with very rare exceptions they no longer burn it.

What they burn today is diesel oil. The United States is largely dependent on imports for supplies of this commodity. On the other hand, the United States has large reserves of coal. Other countries with large coal reserves and little oil, such as Poland, China and some in Latin America and Africa, have retained the steam locomotive. Lately a number of people and organizations, both in the U.S. government and out of it, have started to look at the possibility of a return to coal-fueled locomotives in the United States. In addition, the Chinese have recently shown some interest in selling their coal-fired locomotive technology in the United States.

Recently the Morgantown (W.Va.) Energy Technology Center of the Department of Energy (DOE), which oversees such things for the federal government, published a report, "Assessment of Coal-Fueled Locomotives," on the state of such efforts. The report is one result of renewed attention to the subject that began in earnest about two years ago and gained the support of some members of Congress, including particularly Sens. Robert C. Byrd (D-W.Va.), Paul Simon (D-Ill.) and John Warner (R-Va.). It describes seven projects in fair detail, including a reciprocating steam engine, gas turbines and what are essentially coal-burning



*Hugh W. Crane operates old No. 17, the last steam locomotive in revenue service in the United States. His company's logotype is inset.*

diesels. The organizations that are working on them range from the two largest U.S. manufacturers of the diesel-electric locomotives now used, General Motors and General Electric, to fairly small design and engineering organizations.

However, the president of the railroad that says it runs the last steam locomotive in regular revenue service in the United States feels the report is not as comprehensive as it might have been. Hugh W. Crane of the Crab Orchard and Egyptian Railroad (CO&E) in Marion, Ill., says it omits important information about his locomotive, which he submitted regarding the CO&E's proposal. (The report was compiled from responses to a solicitation published by DOE in the *COMMERCE BUSINESS DAILY* for Nov. 6, 1985.)

**T**he Crab Orchard and Egyptian is an 8-mile line operated by four persons — "If I weren't sitting here talk-

ing to you, I might be out running a train," Crane says. The railroad maintains a steam locomotive of wheel arrangement 2-8-0 (two pilot wheels in front, eight drive wheels, no trailing wheels under the firebox), known in the trade as a consolidation type. It was built in Canada in 1940, and came to the CO&E at second hand from the Roberval Saguenay Railway in Quebec province. The 46-year-old steamer operates competitively with the line's diesels (of model SW 12), Crane says.

Other traditional steam locomotives operate in the United States and Canada but are either found in museums or used primarily for excursions or tourist attractions. The CO&E's consolidation pulls regular freight trains, some of them coal cars, in fact. Crane says he once "ran off" a television reporter who wanted to do a cute story about it. "We're not in it for 'cute,'" Crane says. "If it didn't pull our

train, we wouldn't want it." The steamer runs competitively with the diesels as long as the price of diesel oil is above 50 cents a gallon, he says.

The price of diesel oil right now, as the DOE report points out, is about 40 cents a gallon. It is thus an ironic time for such a publication. The renewed interest in coal fuel began when the price of oil was much higher. However, few believe the price of oil will stay that low for long. Martin J. Hapeman of General Electric says GE calculations relating to their project of a coal-fired diesel locomotive indicate that interest in alternate fuels might return and the coal-fired diesel be profitable to both manufacturer and purchaser when diesel oil hits 85 cents a gallon.

The factors that determine the price of oil are mostly out of U.S. control. "This country is getting like the bears of Yellowstone," says Richard Wolfe, vice-president and director of coal research for the United Coal Company of Bristol, Va. "We're losing our capability to develop our own energy resources." Coal forms a large part of American domestic energy resources, and Wolfe complains that this is a very depressed time for the coal industry, with coal selling at \$20 a ton. The coal industry would like to open new markets. Wolfe estimates the locomotive market as representing 50 million to 75 million additional tons a year or about 10 percent of present production.

**T**here are two basic approaches to the problem of coal as a locomotive fuel (and also as a fuel for marine and stationary engines), Wolfe points out. You can try to make a fuel from coal that will operate existing diesel engines with more or less — preferably less — modification. Or you can burn the coal in a reciprocating steam engine, a steam turbine or a gas turbine and mount that in place of the diesel. Most of the proposals DOE has reviewed want to retain the electric drive of the present diesels.

The standard locomotive of today is actually a diesel-electric. A diesel engine drives a generator that powers electric motors connected to the driving axles. These electric traction motors, as they are called, give advantages in control and pickup that most designers prefer to maintain. Crane, who works with both, describes the difference as one of how the horsepower of the motor relates to its tractive effort, which is how well it pulls cars.

A steam locomotive is relatively hard to start — Crane cites the old saying about steam locomotives: "If you can start a load, you'll pull it along." Steam locomotives work best at fairly high speeds, over 20 miles per hour, he says. Electric traction is easier to start and accelerate and works well at low speeds. Locomotives do much of their most complicated work at low speeds with frequent stopping, starting and reversing, and

most of these designers want to preserve the advantages presented by the electric drive in these operations.

**A**mong the proposals to DOE, the closest to present technology are those of the two large locomotive manufacturers, GM and GE. Each of these companies is working on a modified diesel engine that would use a coal-water slurry instead of oil as fuel. In describing the GM projects, the report notes, "Modification of an existing engine to operate on coal slurry fuel appears to be more feasible than the complete R&D effort required to manufacture a new engine."

The parts of the engine that come in contact with the fuel would have to be modified. Coal does not burn as cleanly as oil, and the engine must resist corrosion by chemicals released in the burning of coal. The DOE report does indicate that more research and development is needed on both the formation of the slurry and coal-resistant materials for the engine. It also points out that for the system to come into widespread use, means for manufacturing, transporting and loading the slurry would have to be developed.

GE's Hapeman points out that GE's cal-

culations allow for these factors. His figure of 85 cents a gallon as the competitive level takes into account construction of their own slurry plants by the railroads. The slurry can be made economically, he says, and adds that a company in Syracuse, N.Y., can process the coal to the 5-micron size they need. GE, he says, has actually run a test diesel engine with the slurry.

Nevertheless, in Wolfe's opinion, a coal-water slurry is not the way to go. It depends, he says, on whether one approaches the problem from the point of view of the locomotive manufacturer, who wants to build locomotives, or of the coal company, which wants to compete with oil fuel. According to Wolfe, United Coal decided to try to produce a liquid fuel from coal that would work in current internal combustion engines. They have done this by a process called "mild gasification," he says, and have run diesel and gasoline engines on it, although not yet a locomotive. At present they have only a very small plant for producing it, he says. They have made presentations at the Morgantown Energy Technology Center, trying to interest DOE. The report states, "In one project, mild gasification fuels were produced and successfully

## Elegy in an abandoned train station

**A**mong my earliest memories is one of sitting on the windowsill in the house where I was born, watching a locomotive move cars on a coal-dumping trestle. I have been fascinated by trains ever since. It's an emotion that affects quite a number of people. I don't know whether it has ever been scientifically analyzed, but one longtime writer about railroads, John H. Armstrong, suggests it has to do with the way trains move.

Trains have a special place in the history of North America. In the United States and Canada railroads not only held each nation together, but in many cases preceded and enabled settlement of the West — a quite different function from what railroads had in Europe and Asia. In the American equivalent of the Icelandic saga or the German Niebelungen cycle, namely the western, there are usually trains around somewhere. For the pious, for those who prefer their trains not carrying gamblers, gunmen and painted ladies, there's the gospel train, which "don't carry no gamblers. . . ." (I have never heard of a gospel airplane.) Those departing this mortal existence left on the midnight train.

Trains in the night. "From Memphis to Mobile, from Natchez to St. Joe," those who sang the blues in the night could always "hear that lonesome whistle

blow." Richard Nixon hated it; I have always loved it.

There's a certain expansiveness, a Vicki Baumish, Grand Hotelish sense of impending adventure about rolling across the landscape in a train. Those whose idea of travel is being confined claustrophobically in a flying tin can can't imagine it. It has affected a number of writers. Particularly it brought forth the rather baroque prose of Lucius Beebe, famous chronicler of the luxe that used to be.

Some of the luxe managed to last even down to the days of Amtrak. Just before Amtrak, I remember entering the first-class diner on the Florida Special and getting a menu listing 15 dishes, plus a complimentary glass of champagne. Even after Amtrak, on the Southwest Limited, there was steak chateaubriand on the menu. Take that, you microwaved cheeseburger!

But romance prints no bank statements. Nevertheless we ought to remember that what was true in 1869 is still true today: Steel wheels on steel rails are still the most efficient way of moving people and goods overland, most efficient in terms of energy consumed, of environmental impact and of psychological impact on the rest of the citizenry. On the day that ultimate gridlock occurs we may remember this.

— D.E. Thomsen

burned for short times in a diesel engine and a small residential furnace. The key unknown that remains is the cost of these coal-derived liquids."

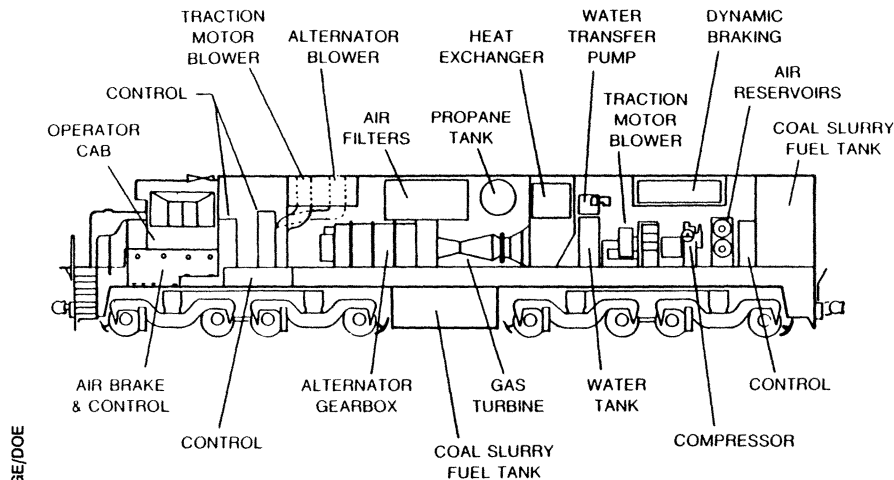
**G**eneral Electric and General Motors are also working on gas turbine locomotives fueled by coal-water slurry. In this arrangement hot gases produced in combustion would power a turbine that powers the electrical generator, and so forth. Back in the 1940s several railroads experimented with gas turbines, including the Union Pacific, the former Chesapeake and Ohio and the former Norfolk and Western. Those experiments were not successful. The Norfolk and Western's reason for dropping the gas turbine then was that it made too big a locomotive, according to Robert Fort, a spokesman for the Norfolk and Western's corporate successor, Norfolk Southern. Lately, Fort says, Norfolk Southern has been studying gas turbines again, but it has turned over whatever it had to GE.

A gas turbine, or possibly a gas reciprocating engine, fueled by run-of-the-mine coal (coal not specially treated), is proposed by Brobeck Corp. of Berkeley, Calif. The locomotive would carry a coal gasifier and the gasified coal would be fed to the turbine. This manner of fueling is preferable, says Kenneth M. Thomas of Brobeck, because "it's not clear that producing the slurry is going to be done on any cost-effective basis."

**O**ther proposals reviewed by DOE use more of the traditional steam technology, and therein lies a psychological stumbling block for present-day railroad managements. As Frederick Prah of National Steam Propulsion Co., a subsidiary of Skinner Engine Co. of Erie, Pa., puts it, "They think going to steam is a step backward." Nevertheless several organizations propose just that step.

In something approximating a traditional steam engine, coal can be burned in a firebox, thus lessening corrosion problems (a firebox has no moving parts). The different proposals use various methods of controlled combustion to minimize unwanted emissions and increase efficiency. Furthermore, they are none of them choochoos. That sound comes from exhaust steam from the cylinders going up the stack. All these steam engines would capture the exhaust, condense and recycle it. This way the locomotive doesn't have to stop every 30 or 40 miles for water as the old ones used to do.

National Steam Propulsion Co. proposes a reciprocating steam engine to power the standard electric motors. It would burn pelletized coal in a fluid-bed combustor. They chose not to connect the reciprocating engine to the wheels in the style of old-fashioned steamers, Prah says, because railroad managements want to keep the diesel-electric drive.



A more modern coal-fueled locomotive is GE's slurry-burning gas turbine.

Another proposal that would use a steam engine to power the electric drive comes from the Crab Orchard and Egyptian Railroad. According to Crane this would be a booster for the existing steam engine to help it in starting and in low-speed operations. The engine would be mounted on the frame of the tender that carries the steam locomotive's fuel and water.

A particular steam engine that might be used for this booster is one made by the Daytong Locomotive Works in China. People from Daytong came to visit the CO&E, Crane says, because they had heard it had the last steam locomotive in revenue service in the United States, and they want to sell their steam engines here.

There have been at least two proposals for a straight steam reciprocating locomotive without the electric drive. The report mentions the North American Locomotive Co. of Monument, Colo., which had proposed a modernized version of a traditional steam locomotive, but it notes: "However, this developer is no longer located in the Monument, Colorado, area, and, if it still exists as a corporate entity, its new offices could not be located."

North American Locomotive Co. is no longer a corporate entity, but its former marketing manager, Asa C. Putnam of Santa Rosa, Calif., told SCIENCE NEWS about the locomotive they had planned. The company fell apart, he says, not because of defects in the product but because of internal disagreements. They were working with the Burlington-Northern Railroad, Putnam says, to develop a reciprocating steam locomotive that would be analogous to one of the biggest of the traditional steamers. The wheel arrangement for this was to be 2-8-8-4, with two separately powered sets of eight drivers. It would have produced up to 14,000 indicated horsepower or a tractive effort of 190,000 pounds. This is three times that of the standard diesel. It would have had a steam turbine electric booster on the tender, adding another 40,000 pounds'

tractive effort.

This model 190, as Putnam calls it, would be fueled by coal chemically treated and pelletized according to the Lurgie process under a German patent. Putnam says he was negotiating for \$3 million needed to build a prototype, when the company folded.

The ACE 3000 of American Coal Enterprises of Lebanon, N.J., is also a modernized reciprocating engine, but somewhat smaller, at 3,000 horsepower (SN:9/26/81, p. 202). Fueled with run-of-the-mine coal, it uses a special double combustion process to increase efficiency and lower unwanted emissions. ACE has been pushing development. Recently, according to Lloyd Lewis, a spokesman for the transportation company CSX, ACE used tracks of a CSX subsidiary, the Chesapeake and Ohio Railroad, for tests involving an old steam locomotive. DOE rates it as a "low-risk near-term technology choice." Some think it could be the first on the rails.

**C**oal may come back as a fuel. According to James Swisher, director of the Coal Research Center at Southern Illinois University at Carbondale, "on paper the railroad industry could save by a shift back to coal if oil prices were higher." Supposing oil prices go up, he foresees the modified steam engines as being most useful in the near term, with the more efficient diesels and turbines coming in later. "Steam engines are inherently inefficient," he says.

It would take development money. Several million dollars is estimated for each of the examples in the DOE report. Hapeman suggests a total figure between \$30 million and \$50 million, and says the money is unlikely to come from the customers.

Railroad managements have usually been reluctant to spend for technological development. Their attitude, as Thomas puts it, is "Show me one I can ride on and pull some cars, and I'll buy it." As Hapeman suggests, that leaves foundations or the federal government as the likely suppliers of development funds. □