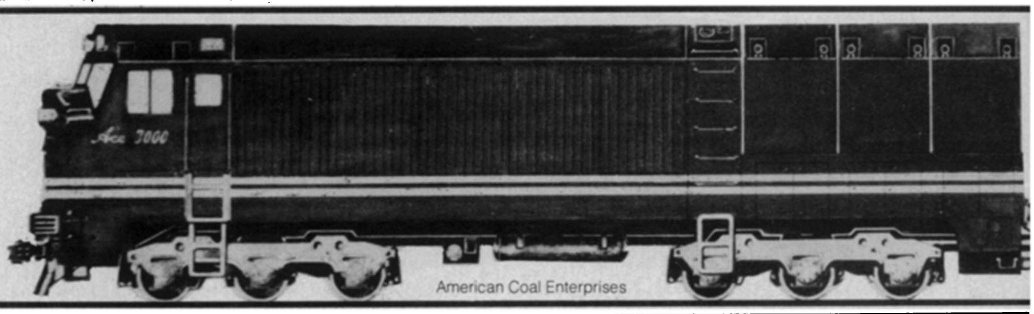
THE LITTLE ENGINE THAT MIGHT



The New York Central System has been summoned to appear at 10 a.m. today in Magistrates Court, 161st St. and Third Ave., the Bronx to face the charges of creating smoke nuisances in its Putnam Division Terminal at Sedgwick Ave. and 165th St., the Bronx. The railroad, if convicted, faces a fine of $25 to $100 on each charge — one specifies that a steam locomotive was issuing "dense" smoke at the yard Dec. 30. . . .

New York Herald Tribune, Jan. 14, 1953

The case cited above is typical of many over the years around the country. It fits the popular perception of the coal-burning steam locomotive: a machine that came whumpf-whumpfing down the track, spraying the environment with cinders, grit and noxious gases.

Steam locomotives were already well on their way out when the New York Central's Putnam Division ran into that particular problem with New York City's Division of Air Pollution Control. Not many months later the Putnam Division retired its last steam locomotive. The harassment of petty fines is not likely to have influenced the railroad management very much; their main considerations were fuel economy, operating economy and ease of maintenance.

The oil-burning diesel-electric locomotive was so superior in these respects that in a decade it drove steam locomotives, which had dominated the industry for 120 years, entirely off the rails. In 1949 new steam locomotives were still being delivered to American railroads; by 1959 the last steam locomotive in regular service in the United States was retired.

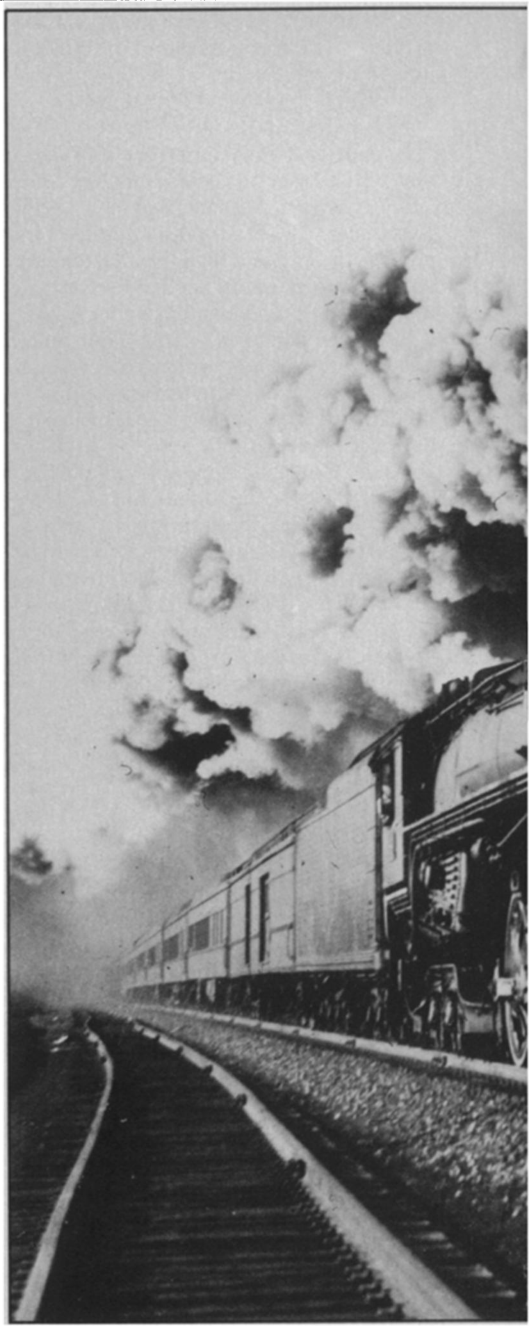
Today, however, the coal-burning steam locomotive seems ready for a return to the rails in the United States. The main reason is again fuel economy—the oil that flowed so cheaply in the late 1940s is now becoming the high-price fuel. Subsidiary reasons are that technical improvements make it possible to design a coal-burning locomotive with operating and maintenance characteristics competitive with those of the diesel.

The design of this sort that seems nearest to reality is called the ACE 3000. It has been drawn up by American Coal Enterprises, Inc., of Akron Ohio, a privately funded corporation "committed to putting coal to use as fuel for this country's railroads." In the terminology of the Future Propulsion Systems Project of the Jet Propulsion Laboratory, which is a three-year study sponsored by the Department of Energy, ACE 3000 represents "first generation steam." That is interpreted by Sidney Liddle, one of the leaders of the JPL study, as "the most advanced coal-fired locomotive that has any chance of working in the next five years." Liddle says he knows of four similar projects, but they are all in the talking or preliminary design stage. He calls the ACE 3000 "a very good engine."

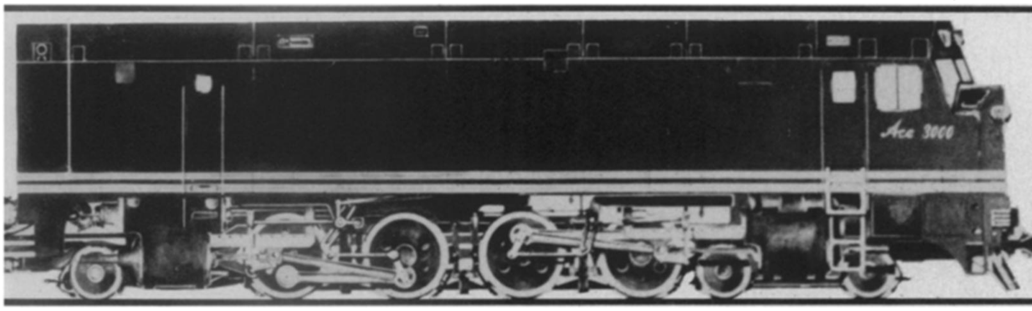
The ACE 3000 is surprising in how much it resembles traditional steam locomotives. In their publicity literature, the designers make a point of how they have built upon 150 years of progress in steam locomotive design. In the 1940s people who wanted to continue to use coal as a fuel on the railroads tried more radical solutions — steam turbines or gas turbines. In these cases either steam or hot gas (both made by burning coal) drives a turbine, which drives an alternator to provide electricity for electric traction motors that drive the wheels. According to the JPL study gas turbines may be useful in generations to come, but the steam turbine is not high on anybody's list. The designers of ACE 3000 chose the traditional railroad configuration, a reciprocating engine, used since the 1820s. In that system, the wheels are driven by rods connected to a piston in a cylinder, which is driven by steam coming directly from the boiler.

According to William Withuhn, executive vice president of American Coal Enterprises, the reciprocating engine has advantages of ruggedness and simplicity. Acknowledging that turbines perform well in static and marine applications, Withuhn says they are too delicate to stand the slams and bangs that a railroad locomotive gets. Turbines also require a high-pressure boiler, which for structural purposes is less suitable on a railroad locomotive.

ACE 3000 uses a "fire-tube" boiler—the low-pressure (300 pounds per square inch) boiler of traditional steam locomotives. In this design, the draft drives burning gases through an array of tubes running through a reservoir of water. The water boils as the fire tubes heat it. Turbines require a "water-tube" boiler, in which the water is led in tubes through the firebox. A fire-tube boiler can be built as an integral structural unit; a water-tube boiler cannot. The fire-tube boiler is thus an important factor of structural stability



Tomorrow and yesterday in steam locomotives. Top: ACE 3000 designers' silhouette. Center: "The Miamian" rolls through Franconia, Va., on the RF&P Railway, March 16, 1947. Bottom: Drive wheel of a late 1940s switching locomotive on the Raritan River RR at Parlin, N.J., exhibits one-sided rod and crank connection. ACE 3000's two-sided drive will be easier on the track.



Pardon me, boy, it's not the Chattanooga choo-choo, but it will burn our most abundant fuel

BY DIETRICK E. THOMSEN

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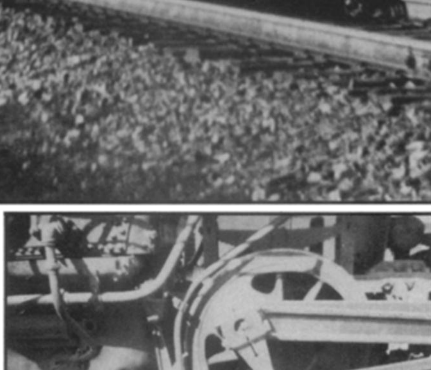


and safety for the engine. In fact, as Withuhn points out, they have proved their ability to survive intact in many a classic train wreck.

It is what happens in the firebox that got the traditional steam locomotive in trouble with both railroad managements and air pollution monitors. The ACE 3000 is expected to please both classes of people with an innovative two-stage burning process designed by Livio Dante Porta, manager of the Rio Turbio Railway in Argentina. In the Porta firing cycle, the coal is made to produce gases, which are then burned. As Withuhn describes it: "The coal just sits there glowing dull red, giving off gases."

This kind of cycle means fuller carbon utilization and, therefore, greater heat efficiency. John E. Sharpe of Queen Mary College of the University of London estimates the thermal efficiency of the ACE 3000 at 15 percent compared to 8 percent for an American steam locomotive of 1950 and 20 percent for a present-day diesel. However, the ACE 3000 uses fuel that costs on the average 3/10 what diesel fuel costs. (This can vary quite a lot depending on whether the railroad in question runs through a coal-bearing region, whether it owns its own mines, etc.) Sharpe figures the ACE 3000's cost effectiveness, therefore, at 2.78 times that of a current diesel, whereas that of the 1950 steam locomotive comes to only 0.78.

The cost ratio is likely to favor coal even more in the years to come. Liddle points out that locomotives have increasingly thirsty competitors for the supply of diesel fuel: home heating, jet airplanes, trucks and private autos. This competition is likely to drive the price of diesel fuel higher yet in proportion to that of coal. The per unit purchase price of an ACE 3000 is estimated at $1,250,000 compared to $791,000 for a 3,000 horsepower diesel, according to the trade magazine RAILWAY AGE. But, the magazine says, the ACE 3000's annualized life-cycle cost (including capital, interest, fuel, maintenance, support operations, taxes and inflation) is about $600,000 while that for a current diesel is $1,175,000.

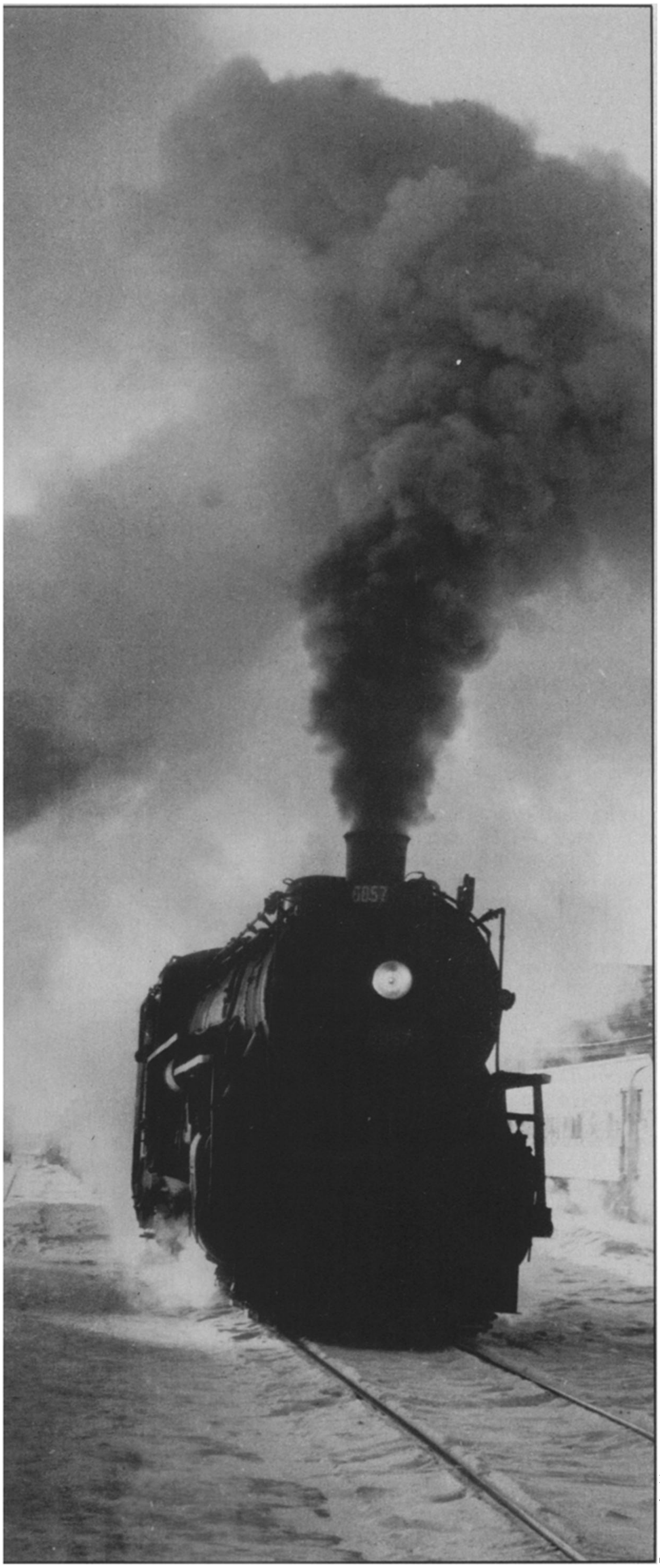
The Porta burning cycle also means less polluting burning. Particulates are held to a minimum by the way the draft is managed. On gaseous emissions Sharpe writes: "With the fuel bed temperature controlled to below 950° C, production of nitrous oxide is minimized and clinker is not formed. The secondary combustion ensures that all CO is burnt to CO_2 with a minimum of excess oxygen." Sulfur dioxide emission depends on the sulfur content of the coal. ACE 3000 is designed for low sulfur coal. (The JPL report speaks of a "second generation steam" engine, which would have fluidized-bed combustion and could burn high sulfur coal.)

One of the complications of the sulfur question is that there are really no standards for small, moving boilers. Withuhn figures that when the standards are set, they will be much less than the 4 pounds per million BTU allowed for large stationary plants, but he points out that burning 1.5 percent sulfur coal, ACE 3000 would emit 1.8 pounds per BTU of sulfur oxides. Coal of that quality is available in both the eastern and western U.S. fields.

Fuel efficiency and relatively clean running are not the only considerations. Railroad managers also look at running qualities and maintenance. The traditional steam locomotive had the drawback of "hammering" the track as it ran. The one-sided piston thrusts of the traditional engine meant that the drive wheels had to be counterweighted. But the counterweights unbalance the vertical thrusts, and so in every revolution the track took a blow from the counterweights. This means more frequent track maintenance.

ACE 3000 avoids hammering with a four-cylinder opposed-thrust drive instead of the traditional one-sided two-cylinder drive. This system, attributed to Withuhn, delivers thrusts to the wheels from front and rear at once. Counterbalancing is not necessary, and there will be no "hammering."

The steam exhausted from the cylinders of the traditional locomotive was sent up the stack where it created the choo-choo sound and also created a draft that roared through the firebox, pulling all kinds of grit up the stack. In the interest of controlled burning and of filtering out whatever particulates do get produced, ACE 3000's drafts will be controlled by computer, and the steam will be condensed and recycled. This recycling means the ACE 3000 could run long distances — "from Chicago to Denver," Withuhn says — without taking on water. The traditional locomotive stopped every 30 or 40 miles for water. For the ACE 3000 fuel would have to be taken in more often than water, about every 500 miles. Fuel would be delivered in preformed blocks, and ash would be taken out



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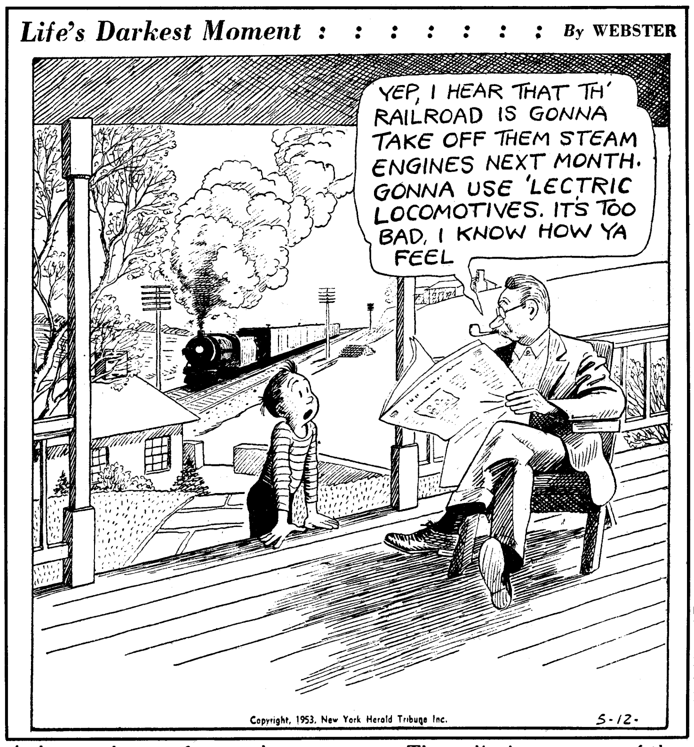

New York Herald Tribune

A dense plume of smoke rises as a train prepares to leave Port Arthur (now Thunder Bay), Ontario, on the Canadian Pacific Railway (left). Unhappiness with pollution and thermal inefficiency led to the replacement of steam locomotives in spite of what little boys thought (above). Livio Dante Porta (below) designed the firing system for the ACE 3000, which is expected to meet those objections and bring back steam.

American Coal Enterprises

the same way. That eliminates two of the dirtiest operations in old-fashioned locomotive terminals.

The traditional steam locomotive was controlled by an array of levers, rods and valves that the driver manipulated largely by sense of touch. Getting two of them to operate in tandem meant careful cooperation between two crews. A slip-up could mean flat wheels or more serious damage. ACE 3000 is designed to be run by a microprocessor, the same sort as controls current diesels. That means that ACE 3000s can be operated in groups with other ACE 3000s or with diesels by a single crew.

Throughout the design, advantage has been taken of modern developments in lubrication, bearings, fastenings, etc., so as to make parts standard and maintenance easier. John H. Armstrong, associate editor of Railway Age, has talked to a number of middle-level railroad officials about the ACE 3000 and says that on the basis of their technical judgment such people as maintenance and mechanical officers or trainmasters generally are convinced that it can be maintained.

Apparently the higher level officials are becoming convinced that it can be built and run. Withuhn, Liddle and Armstrong all cite the interest of various railroad companies, especially western coal haulers, but the companies decline to be identified. According to Armstrong several senior officials said they thought there would be a coal burner on the rails within the decade.

The next step for ACE 3000 is to find the $25 million to $30 million in capital necessary for development and to produce a few demonstration models. And, Withuhn says, negotiations with potential investors have already begun. □