Feature Articles

The Transportation Test Center: A Sign of Rail Progress

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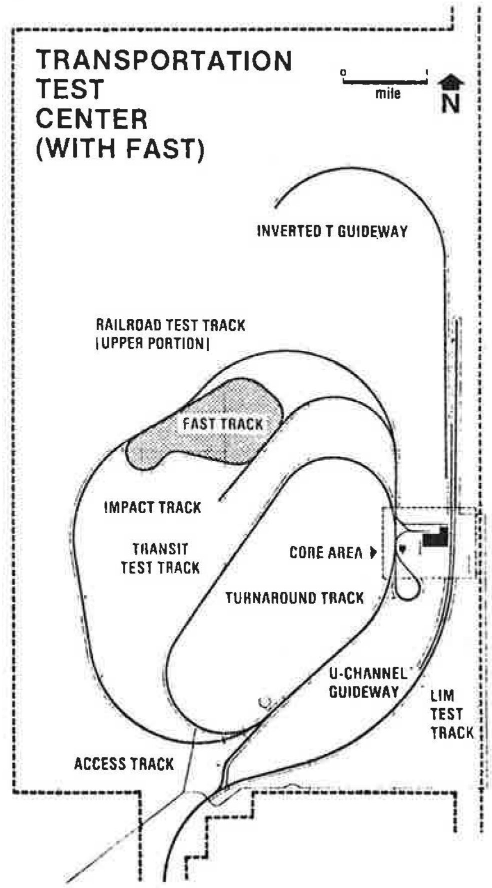
Evidence of the resurgence of rail transport can be seen in many places: ConRail's track rehabilitation in the northeast; sophisticated new automated classification yards such as those of the Santa Fe at Barstow, California, the Southern Pacific at Colton, California, and the Southern at Sheffield, Alabama; new subways under construction in Washington, Baltimore, and Atlanta; and major media advertising campaigns by the railroads.

But nowhere is there better evidence than in the rangeland northeast of Pueblo, Colorado. There in the shadow of Pikes Peak, where cattle grazed a few years ago, is the Transportation Test Center of the U.S. Department of Transportation. Here the latest developments in railroad and transit technology are tested under almost every conceivable operational condition, including accidents. The test center, managed by the Federal Railroad Administration (FRA), is fast becoming to rail technology what Cape Canaveral is to space technology. Space age instrumentation and data acquisition equipment can be found on test trains, along the test tracks, and in the laboratory.

Ground was broken for the first test facility in August 1970, and in the 6½ years since more than $52 million has been invested in test and support facilities. The center has available 130 km² (50 miles²) leased from the state of Colorado at a cost of $10 for 50 years (Figure 1). The present facilities occupy little more than half the area, leaving room for future expansion.

Employment has reached about 350. About 325 are employed by the operations and maintenance contractor and the remainder by the government.

Figure 1 The layout of the tracks at the Transportation Test Center.



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Results of a locomotive/caboose test. The caboose traveled up and over the hopper car.

The center is playing a major role in fostering cooperation between the government and the rail industry. From the time the center was started, the U.S. Department of Transportation planned for its use by private industry as well as by government. Industry leaders have recognized the test center as an invaluable development tool, the like of which has never before been available to either carriers or suppliers. Industry has not been content just to use the available facilities, but has assisted in planning for new facilities, obtaining construction materials, and lending of test equipment.

Such participation has made possible an early start-up of the newest test track, the Facility for Accelerated Service Testing (FAST). FAST is designed to replace the railroad practice of putting a limited number of track or equipment components into service and observing their performance for 10 to 20 years. This test track is a 7.7-km (4.8-mile) loop with 22 sections, each containing a different combination of track components. For 16 hours a day, 5 days a week, an 8600-Mg (9500-ton), 75-car train circles the loop at speeds as high as 72 km/h (45 mph), subjecting the track to more than 272 Tg (300 million gross tons) a year. This is the equivalent of approximately 10 years of experience on the most heavily used main lines in North America and will thus provide life testing of both track and cars in one-tenth or less of the time it would take in revenue service. The test train runs from 3:00 p.m. to 7:00 a.m. so that the daytime can be used for inspecting, maintaining, and turning the train around so the wear will be equal in both directions.

FAST could not have come into existence within several years of the time it did except for extraordinary help from both rail carriers and suppliers. A preliminary plan for FAST was developed by the Association of American Railroads for the FRA. The railroad's enthusiasm for a test facility that could compress 10 years of operation into a year of test was clearly expressed when Stanley Crane, president of the Southern Railway Company, urged an immediate construction start without waiting for a government budget request to proceed through all the levels of approval that could have taken years. Consequently, the railroad industry supplied most of the track components and ballast along with the locomotives and cars, while FRA funded construction and is funding operation out of funds on hand.

With the opening of FAST in September 1976, the center's rail test tracks now total approximately 35 km (22 miles). Other test facilities include a dynamics laboratory for vibration testing of cars and locomotives and a flame test facility to test thermal insulation coatings of tank cars that carry hazardous materials. The test tracks include a transit track built by the Urban Mass Transportation Administration. UMTA also shared in the cost of constructing the dynamics laboratory.

Of all the tests that have been run at the center, the most spectacular was the crash of a locomotive into a standing train and caboose. The speed was 48 km/h (30 mph) when the locomotive struck the 36.3-Mg (40-ton) caboose and drove it up on top of the hopper car in front of it. In an actual accident, occupants of either locomotive or caboose would have been seriously or fatally injured. This was the highest speed in a series of impact tests that were run to study vehicle crashworthiness and provide information for the design of safer locomotive cabs. The data accumulated from cameras, accelerometers, and strain gauges have been used to verify mathematical models so that new locomotive cab and car designs can now be tested in a computer without having to destroy equipment. This program is a cooperative one, sponsored by the Brotherhood of Locomotive Engineers, the Association of American Railroads, and FRA.

Other crash tests have simulated impacts of tank cars in the switchyard. A test, run in October 1976, gives a good example of what can happen in a switchyard when things go wrong. A 113 550-liter (30 000-gal) water-filled tank car, coupled to a hopper car on one end, was struck by another hopper car (pushed by a locomotive) on the other end, simulating an attempt to couple at too high a speed. At impact, the hopper car body was lifted off its trucks and impaled the end of the tank car, sending torrents of water cascading onto the track. If the tank car had contained flammable or explosive liquids, the result of such a switching impact could have been disastrous. Tank car fires and explosions have devastated large areas around rail yards, and poisonous gas leaking from ruptured tanks has forced evacuation of a whole town. The towns of Crete, Nebraska, and Laurel, Mississippi, among others, have experienced such catastrophes in recent years.

Analysis of the way in which failure occurs in these staged tank car accidents will bring improved designs and better protection against such accidents. This, too, is a cooperative program of the Association of American Railroads, the Railway Progress Institute, and FRA.

Freight equipment tests do not represent all the activities at the test center; transit and, until recently, advanced design ground systems have occupied a large share of the center's investigations. The first high-speed test track, the linear electric motor research vehicle facility, which was opened in 1971, is still in use. This is a 10-km (6.2-mile) railroad track, conventional in design, except for unequaled accuracy in alignment and the presence of a vertical aluminum fin down the center fastened to the crossties. In 1974, this track was the scene for setting the world speed record of 411 km/h (255.4 mph) for steel wheels on steel rails. The record was set by an unmanned, streamlined rail car propelled by a linear electric motor, of which the vertical aluminum fin is part. The record-setting run was preceded by a dozen runs of more than 321 km/h (200 mph), which provided not only data on linear electric motor performance but also valuable insights into rail dynamics. Data collected during these runs showed a ride smoothness that surprised even the Budd Company, designer of the rail car suspension, which was an off-the-shelf passenger car truck with the stiffness of elastomer springs changed.

The second facility built is the UMTA rail transit test track. The 15-km (9-mile) oval has been used continually since it opened. Until the railroad test tracks were completed, both railroad and transit vehicles were tested there. Sometimes transit testing was carried out during the day and railroad testing at night.

The first international railroad test was run on the transit loop. A Canadian consortium brought a prototype of a new high-speed passenger train to the center. This train ran more than 32 000 km (20 000 miles) in 6 weeks—exceeding 1610 km (1000 miles) per day. Last year, Amtrak ran a similar 16 000-km (10 000-mile) test program on its new passenger cars before putting them into service. Earlier, Amtrak, together with the locomotive manufacturer, ran tests of a new high-speed passenger locomotive truck to investigate the forces imposed on the track.

Two manufacturers of freight car trucks, ASF and Dresser Industries, have run ride quality and other tests on proprietary designs of new trucks. Both manufacturers brought their own trains consisting of the car with the experimental trucks and supporting instrumentation cars. In such cases, the role of the test center is one of technical and logistical support. The test data are owned

The aerial view of the Test Center shows Pikes Peak in the distance. The access bridge in the foreground crosses the Linear Induction Research Vehicle Track and the Tracked Levitated Research Vehicle Guideway. The large buildings are, from left, the Central Services Building, the Rail Dynamics Laboratory, the Project Management Building, and the Operations Building. Railroad test tracks are in the right background.

by the company conducting the tests and are not distributed by the government.

The transit test programs run by the contractors for UMTA include the state-of-the-art cars and standard light rail vehicle by Boeing-Vertol and the energy storage cars and gas turbine-electric cars by Garrett Corporation. The state-of-the-art cars represent the best transit car possible with off-the-shelf components. The standard light rail vehicle is a modern articulated surface transit car. Boston and San Francisco have them on order (see *Transportation Research News,* September-October 1976).

The gas turbine-electric cars are designed for service such as that on the Long Island Rail Road, where electrification has not been extended to the outer end of the commuter runs and passengers have to change from electric to diesel trains at an intermediate station. The new cars can run straight through by switching to gas turbines at the end of the third rail.

The stored energy system was tested on two New York City subway cars and consists of flywheels, which operated in a vacuum (to lower aerodynamic friction), are spun up to speed during braking, and return energy to the traction motors during acceleration. Power costs are reduced and the energy of braking is not dissipated as heat, which affects other car equipment and raises the temperature in subway tunnels.

The Rail Dynamics Laboratory is only partially complete, but test programs have been run on its vertical shaker. The shaker simulates track conditions by subjecting rail cars to vibration over a wide variety of frequencies and amplitudes. The roll, bending, and other movements of the car are measured by instruments that feed their signals to a special computer. The computer records and analyzes the data and feeds back control signals to the shaker. Piggyback trailers have been tested to investigate actions of the flatcar and of the highway trailers on it. The purpose is to reduce damage from vibration and swaying. The U.S. Department of Agriculture is interested in the possibility of reducing damage to fresh fruits and vegetables.

The U.S. Department of Defense has sent a series of hazardous material cars (including cars for carrying nuclear fuel) to the test center for stability testing as a precaution to ensure safe movement of such materials.

The operation of a torch test facility is another part of the tank car safety project. Sections of steel tank wall plates, coated with thermal insulation, are subject to high temperature flames to determine the added protection to the lading. That is, How much longer will a coated tank keep the contents below the temperature at which they will get hot enough to explode? Models of tank cars can also be tested for other aspects of safety, such as improved vent valves.

Other countries are interested in the test center facilities and operations for possible use or as guidance in developing their own test centers. The Canadians are studying their requirements to determine whether they should build their own or arrive at an agreement for long-term use of the center. The West Germans are planning a ground transportation test center near Donnaureid in Bavaria and have sent a group to the test center to get information to use in their planning of facilities.

The only country with a test center of the capability of the Transportation Test Center is the USSR. The Russian center is part of a large research complex including a number of laboratories. Even though the Russian center was begun in the 1920s, the full-scale test facilities have been surpassed by those at Pueblo.

The question is often asked, When will the test center be finished? The answer is, If all goes well, never! As technology progresses and the rail industry progresses, new opportunities will arise and new kinds of testing and new facilities will be needed. When new test facilities are no longer needed, stagnation will have set in.

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1 Comparative ride quality characteristics are tested of the Canadian LRC (Light, Rapid, Comfortable) high-speed prototype coupled to a bi-level Amtrak coach.

2 A trailer train car loaded with highway trailers undergoes vertical shaking tests in the Rail Dynamics Laboratory.