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Levitated train speeds without wheels

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Emsland, Germany—The three cars of train TR08 stand at an elevated platform, bright in their livery of white and red. The first car contains instrumentation while the other two carry passengers—as many as 200 in a comfortable 3 + 2 configuration.

A warning signal sounds and the doors close. A moment or two later and the train rises from its track and moves silently forward. Inside, a digital display shows speed in kilometers per hour. The digits change quickly: 30 within a second or two, 300 in a minute and a half. That is equal to 185 mph, reached when the train has traveled two and half miles down the track. And it gets faster—on this trip, the display creeps steadily up to 400, 405, 409, and finally 411. That means 255 mph. Maximum speed is 342 mph.

The silent speedster on which we are traveling is Transrapid's maglev, a train without wheels that could revolutionize transportation from city-center to city-center. The ride is smooth as the train speeds six inches above the track, riding on the lift, not of air, but of a local magnetic field.

Magnetic attraction. Packs of magnets (see photo) mounted in the lower valance of the train's bodywork act as the excitation component—like the commutator in an ordinary electric motor—levitating the train over its guideway. The power supply varies from 12 to 15 kV, with electricity energizing each stator as the train passes it. But instead of the rotary magnetic field generated in a conventional electric motor, the stator coils of the linear motor are mounted beneath the guideway, generating a traveling electromagnetic field along which the train is borne, like a surfboarder. And that field is precise—positional accuracy is ±0.375 inch.

Also mounted on the lower part of the train are guidance magnets to keep the train accurately on its track. The clearance between the magnetic surfaces and the guideway is less than half an inch.

How about stopping? Passenger comfort demands that acceleration is kept to 1.5 m/sec2, or about 0.15g. In an external power loss, eddy current brakes automatically bring the train down to 6 mph, then it sets down on mechanical skids to slide to a stop.

No driver, no maintenance. Trans-rapid runs automatically. There is no driver; just a supervisor acting as lookout. A control center manages all operations, from train speed to station equipment. It has line-of-sight data links to trains via intermediate radio antennas, and digital markers confirm trains' positions.

Because of multiple design redundancy, there is no preventive maintenance on Transrapid. Individual units can fail without degrading the performance of the train.

"This is in sharp contrast to conventional railway procedure, where maintenance follows an inverse square law, rising much higher than increases in speed," explains Bob Budell, sales and marketing manager at Transrapid. "This is why DB (Deutsche Bahn railways) says it will restrict operational speed of its ICE (Intercity Express) to 170 mph on future lines."

Safety first. Still, the German Transport Ministry demanded extensive safety studies. The train's derailing from its track is virtually impossible, since it is almost wrapped around the guideway. For power, it has multiple redundancy built-in, with four power supplies and four battery packs per car, capable of sustaining levitation for a while in the event of sudden power failure. For emergency exits, there are fabric exit tubes at each door, similar to those used on tall buildings. And for fire, doors between cars have 30-minute fire resistance, and all panels and furnishings are made from aircraft-rated materials.

In 1991, Transrapid obtained a public transport license. Since then, the test site has also become a tourist attraction, carrying 370,000 passengers on test rides. Visitors can also watch Transrapid sweeping by from a viewing hill not 30 yards from the guideway. At high speed, the train passes in a moment, not silently but certainly making far less noise than an 18-wheeler on a nearby freeway.

The 19-mile test track at Emsland runs in a figure-eight shape over farms and heath land. Most is on elevated structure about 20 feet high but some track is only a few feet above the ground. It first opened in 1984, with the present train—the eighth generation—introduced in 1999. Its predecessor, the TR07, was tested for 10 years at the facility, running for 24 hours continuously on two occasions.

Seeking customers. The first contract for Transrapid is in China for a link between Shanghai and Pudong International Airport. This is due to start running in 2003, achieving full operational use the following year. The journey will take eight minutes, with a five-car train departing every 10 minutes.

Transrapid is also looking at projects in Germany, the Netherlands, and the U.S. Three potential projects in the U.S. are competing for funds from the Maglev Development Program (MDP): Washington-Baltimore corridor, greater Pittsburgh, and Las Vegas. The 37-mile Washington-Baltimore Project could be the first stage of a long-distance maglev route running 800 miles from Charlotte, NC to Boston, MA. Transrapid would do that trip in less than 4½ hours.

"We think there are niches in the transportation environment for which maglev technology is ideal," says Chris Brady, president of Transrapid-USA. "High speed rail and air travel have their place, but for 40-300 mile sectors between large city centers, maglev is best."

The speed, safety, quietness, low energy requirements, low maintenance, and minimal land-take of maglev technology make it not so much a competitor as a complement to busy railroad networks or overstretched airports.