HIGH-SPEED TRAIN SYSTEMS

Prepared

by

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TABLE OF CONTENTS

WHAT IS A HIGH-SPEED TRAIN SYSTEM?

I.

EXISTING HIGH-SPEED TRAIN SYSTEMS

High-speed trains are a form of rail transport in which trains are electrically propelled at speeds exceeding 150 mile per hour. These trains currently operate in regular revenue service at maximum speeds of about 200 miles per hour, but have been tested at nearly 360 miles per hour. At high speeds, trains must be completely grade-separated, meaning there are no at-grade crossings with roads or other types of transportation; the tracks are fenced to prevent intrusion; and the trains must run on new, dedicated alignments that are very straight. High-speed trains also must have sophisticated, modern signaling and automated train control systems. High-speed trains are a very safe, efficient, reliable and pleasurable way to travel between destinations that are generally between 100 to 500 miles apart. Utilizing a fraction of the energy per passenger of automobiles and jets, high-speed trains are the safest mode of transportation. Where they serve heavily traveled corridors, high-speed train passenger revenues generally exceed operational and maintenance costs.

Figure 1.1 German ICE3 High-Speed Train

Figure1.2 High-Speed Train in Taiwan

Presently, two high-speed train technologies exist in the world: steel-wheel-on-steel-rail systems and magnetic levitation (Maglev) systems. The Japanese Shinkansen, or “bullet” train, the French TGV and the German ICE are all examples of steel-wheel-on-steel-rail systems. These are high-tech train systems that vastly improve upon traditional passenger rail technology. High-speed steel-wheel-on-steel-rail systems have been extensively proven in revenue service, carrying over nine billion passengers to date.

A. HIGH-SPEED TRAINS IN JAPAN AND ASIA

The Skinkansen was first introduced in revenue service in Japan in the mid-1960s with a 343-mile line connecting Tokyo and Osaka. Today, the Shinkansen network totals over 1,350 miles, connecting Japan's major metropolitan areas and carrying over 335 million passengers every year. While operating hundreds of high-speed trains each day, the Japanese have a perfect safety record and near perfect on-time performance, with an average deviation from schedule of only about 18 seconds. Other Asian nations have now implemented steel-wheel-on-steel-rail high-speed systems of their own. New high-speed train systems are now operating in Korea, Taiwan, and China—with China having massive plans for expansion.

Figure 1.3 Japanese Shinkansen JR 500 High-Speed Train

B. HIGH-SPEED TRAINS IN EUROPE

High-speed train service began in France in 1981 and in Germany in 1991, although planning for the lines began in the late 1960s and early 1970s. In Europe, high-speed trains operate not only over specially engineered high-speed lines, but also at reduced speeds over improved "conventional" rail lines used by other rail services as well. Thus, the reach of the high-speed service is far greater than the length of the new high-speed lines. In France, the TGV network began with the construction of a 186-mile high-speed segment that served an improved rail network of 550 miles. Today, the TGV network consists of over 1,160 miles of new interconnected high-speed lines and operates on a total network of nearly 4,850 miles of improved rail carrying over 100 million passengers every year. High-speed trains now operate through and connect England, France, Belgium, Germany, Italy and Spain. By 2030, there will be a fully integrated high-speed train network throughout Europe (see Figures 1.5 and 1.6).

Figure 1.4 French New Generation AGV high-speed train.

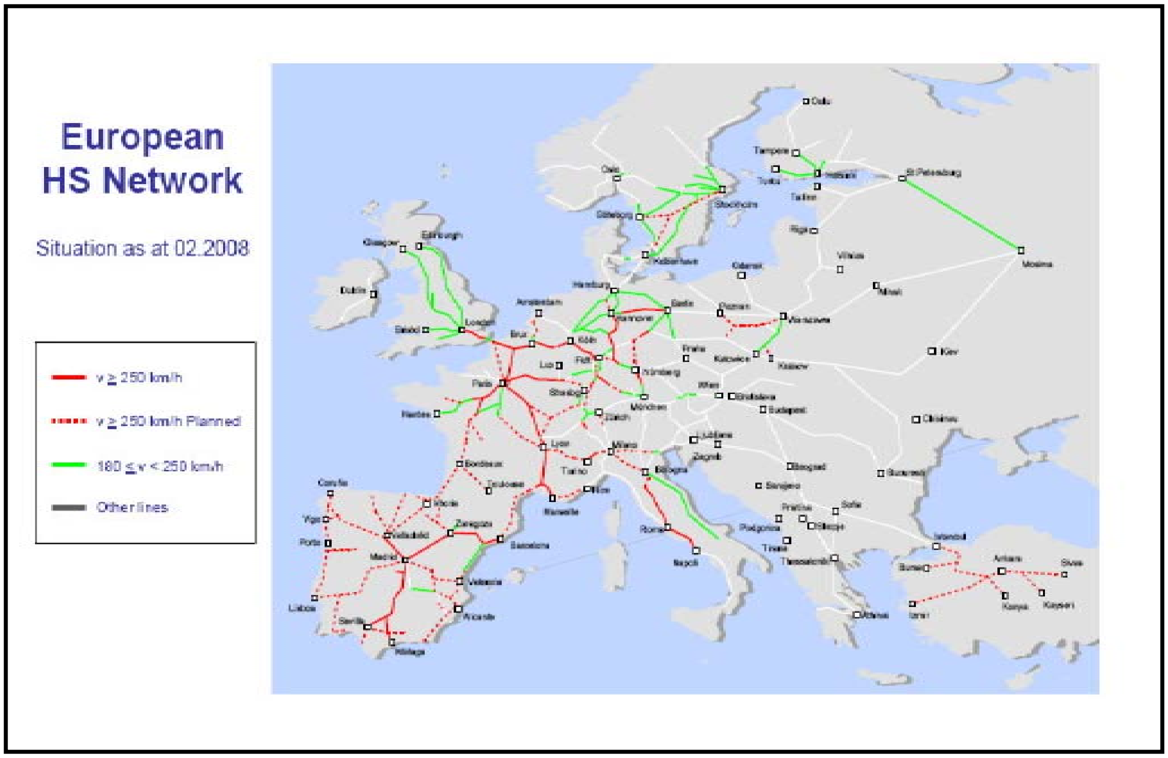

Figure 1.5 European Network as of February 2008

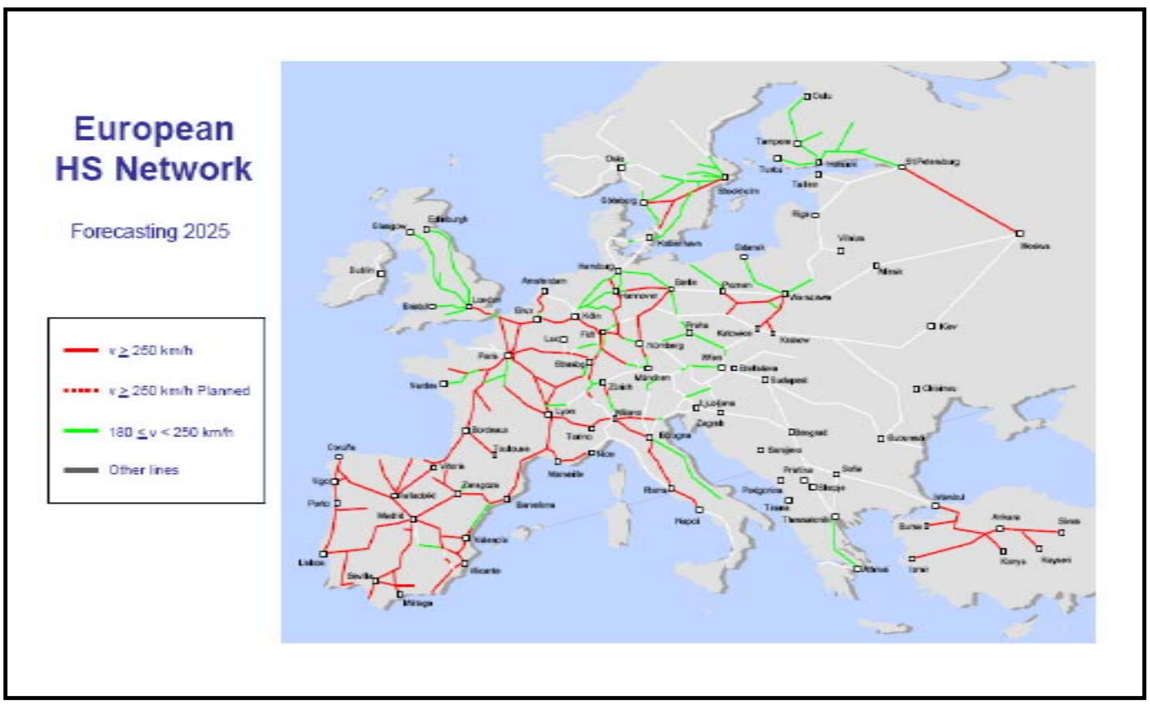

Figure 1.6 European Network planned for 2025

C. MAGNETIC LEVITATION SYSTEMS (MAGLEV)

Maglev systems are a completely new technology that departs from the wheel-rail-on-steel-rail system by using either attractive or repulsive magnetic forces to lift and propel the vehicles along a guideway. Because Maglev trains hover above a guideway, these systems create no friction or rolling resistance and are expected to travel at even higher speeds than steel-wheel-on-steel-rail systems. There are no intercity Maglev systems operating in revenue service anywhere in the world. However, both Germany and Japan have been developing and testing Maglev prototypes on test facilities for many years, with a 19-mile Maglev demonstration project (using German technology) in Shanghai, China, which began operations in 2004. The Shanghai Maglev system connects the Pudong International Airport to Pudong and reaches maximum operating speeds of nearly 270 mph.

Figure 1.7 Transrapid Maglev trainset in Shanghai

D. HIGHER SPEED TRAIN SERVICE IN THE UNITED STATES

In the United States, Amtrak's "Acela" service between Boston, New York City and Washington, D.C., is the only rail service that approaches high-speed standards traveling at maximum speeds up to 150 mph on portions of the alignment. Acela trains make the 226-mile trip between New York and Washington, D.C., in about 2.5 hours. To accommodate the Acela service, a large improvement project to electrify and upgrade service from New York City to Boston was completed in 2000. The Acela trains are fully compatible with the other conventional Amtrak, commuter rail, and freight services operating between Washington, D.C., and Boston. According to Amtrak, the popular Acela service operates at a revenue surplus.

Figure 1.8 Passengers relaxing on board

II.

HIGH-SPEED TRAINS FOR CALIFORNIA

The decision to choose a particular type of high-speed technology for California was made as part of the ongoing environmental clearance phase of this project.[1] The Authority selected steel-wheel-on-steel-rail technology which is extensively proven in intercity operations throughout the world. This type of technology would be able to share tracks at reduced speeds with other compatible conventional rail services. There are a number of potential steel-wheel-on-steel-rail manufacturers able to compete for the opportunity to use their technology in California, ensuring the best product for the best price.

Figure 1.9 Passenger enjoying the dining car

Steel-wheel-on-steel-rail high-speed trains will offer Californians a new way of traveling. Combining the benefits of moving from one part of the state to another quickly with the freedom to plug in your computer or talk on a cell phone or get up to get a cup of coffee, high-speed train travel promises Californians a relaxing, productive trip. Tables would be available for group seating, with conference rooms available for business meetings en route. Because they travel over new, dedicated infrastructure, trains traveling at high speeds provide an extremely safe, smooth and comfortable ride, and seat belts are never needed. And high-speed trains are the most reliable way to travel, not hampered by rain, fog or interstate freeway delays in completing their scheduled runs.

A. DESIGN STANDARDS FOR CALIFORNIA

Drawing upon many prior feasibility and corridor evaluation studies, the Authority and the Federal Railroad Administration (FRA) defined performance criteria for the high-speed train system summarized in Table 1.1. For the high-speed train system to provide competitive travel times and be economically feasible, maximum operating speeds must exceed 200 miles per hour. For planning purposes, the Authority and FRA have assumed that the proposed "next generation" steel-wheel-on-steel-rail trains would operate at speeds up to about 220 mph (350 kph). However, these trains will not operate at those speeds everywhere in the state. Within the state's urban regions, high-speed trains will likely travel at maximum speeds between 100 and 150 miles per hour.

Figure 1.10 A simulation of a dining car

[1] See "Final Program EIR/EIS for the Proposed High-Speed Tr ain System" certified November 2005.

The high-speed train system infrastructure will be a state-of-the-art, proven, world-class technology that significantly increases the state's transportation capacity. The system will be completely double-tracked to provide the necessary high capacity, flexibility and reliability.

The safe operation of the high-speed train system will be of the utmost importance. To this end, the high-speed train system will be a completely grade-separated and fully access-controlled infrastructure with intrusion monitoring systems. This means that the high-speed train infrastructure (e.g., tracks, and maintenance and storage facilities) would be designed to prevent access by unauthorized vehicles, persons, animals and objects. Using modern signaling technology, trains on similar infrastructure in Asia and Europe can operate at three-minute intervals. High-speed train systems have proven to be the world's safest, most reliable form of transportation.

The electrically powered high-speed train system would draw electric power from overhead wires connected to the commercial power grid and, in braking, would regenerate electricity back to the grid, thereby conserving power and reducing costs. To maximize the environmental benefits of the high-speed train system, the Authority has adopted a policy to use only renewable sources of electric power.

Figure 1.11 Another interior simulation

Table 1.1
High-Speed Train Performance Criteria

CATEGORY	CRITERIA
System Design Criteria[2]	Electric propulsion system. Fully grade-separated guideway. Fully access-controlled guideway. Guideway with intrusion monitoring systems. Track geometry must maintain passenger comfort criteria (smoothness of ride, lateral acceleration less than 0.1 g [G forces]).
System Capabilities	All-weather/all-season operation. Capable of sustained vertical gradient of 3.5% without considerable degradation in performance. Capable of operating parcel and special freight service as a secondary use. Capable of safe, comfortable and efficient operation at speeds over 200 mph. Capable of maintaining operations at 3-minute headways. Capable of traveling from San Francisco to Los Angeles in approximately 2.5 hrs. Equipped with high-capacity and redundant communications systems capable of supporting fully automatic train control.
System Capacity	Fully dual-track mainline with off-line station stopping tracks. Capable of accommodating a wide range of passenger demand (up to 20,000 passengers per hour per direction). Capable of accommodating normal maintenance activities without disruption to daily operations.
Level of Service	Capable of accommodating a wide range of service types (express, semi-express/limited stop and local).

In general, the high-speed train system will be built at-grade and require a corridor less than 50 feet wide (see Figure 1.12). In severely constrained urban areas where grade separation costs or environmental impacts are prohibitive, aerial structures (Figure 1.13), retained fill, trenches or even tunneling are potential solutions. By comparison, a 12-lane freeway constructed to Caltrans standards requires a nearly 225-foot wide right-of-way.

[2] *Engineering Criteria*, January 2004.

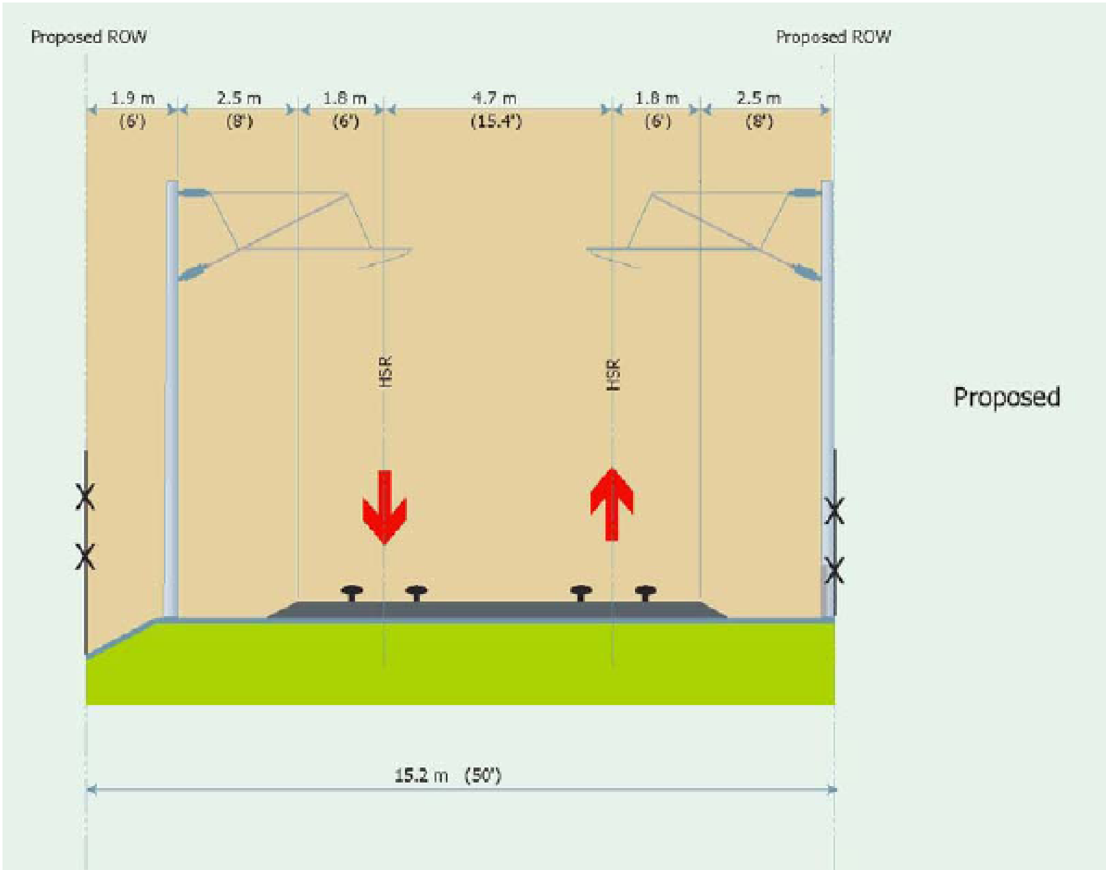

Figure 1.12 Standard ROW Profile

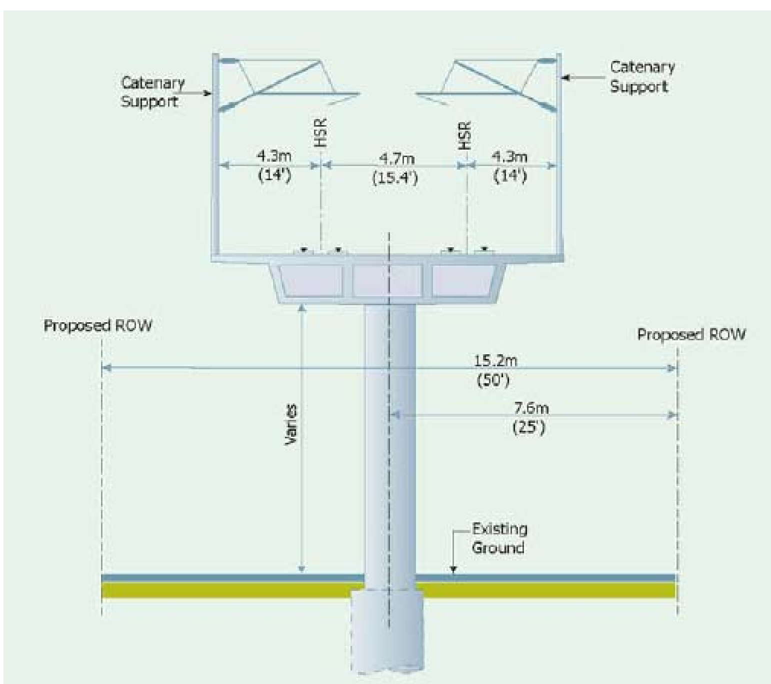

Figure 1.13 Aerial Structure

All intermediate stations will feature siding tracks to allow express trains to pass through without slowing down. High-level boarding platforms will facilitate passenger loading and unloading as well as meet requirements for disabled passengers under the Americans with Disabilities Act. Each station will be a transportation hub connecting the high-speed train system to conventional rail, transit, highways and air transportation networks, as appropriate.

Operating "trainsets" will have multiple cars and will be up to 1,300 feet long, depending on the type of train and the market demand. At peak travel times, trains can be lengthened, or trainsets can be connected, to operate as a single train, providing seating for up to 1,000 passengers. To put the total available capacity of this system into perspective, consider that the signaling system would permit trains to run every three minutes; trains carrying 1,000 passengers every three minutes in both directions could serve up to 40,000 passengers per hour—much greater than the number of passengers currently moved on a 12-lane urban freeway during peak periods. The high-speed train infrastructure would provide capacity to serve California's growing transportation and mobility needs to move intercity passengers, commuters and goods throughout the 22nd century.

B. COMPATIBILITY WITH OTHER RAIL SERVICES

To operate at high speeds, a dedicated, fully grade-separated right-of-way is necessary with more stringent alignment requirements than those needed for lower-speed lines. Therefore, this state-of-the-art, high-speed, steel-wheel-on-steel-rail technology would operate in the majority of the statewide system in dedicated (exclusive track) configuration. However, where the construction of new separate high-speed train infrastructure is not practical, shared track operations could be used. It would be possible to integrate high-speed systems into existing conventional rail lines in the congested urban areas with resolution of potential equipment and operating compatibility issues by the FRA and the California Public Utilities Commission. Potential shared-use corridors would be limited to sections of the statewide system with extensive urban constraints. Shared-use corridors would meet the following general criteria in addition to the performance criteria:

- Uniform control/signal system.
- Four tracks at stations (to allow for through/express services and local stopping patterns).
- Three to four mainline tracks (depending on capacity requirements of high-speed train and other services).
- Physical or temporal separation from conventional freight traffic.

While the high-speed train system is not compatible with typical U.S. freight equipment and operations, the proposed high-speed train system could be used to carry small packages, parcels, letters, or any other freight that would not exceed typical passenger loads. This service could be provided either in specialized freight cars on passenger trains or on dedicated lightweight freight trains. Moving medium-weight high-value, time-sensitive goods (such as electronic equipment or perishable items) on the high-speed train tracks would also be a possibility but would need to be operated overnight when it wouldn't interfere with passenger operations and would require additional facilities for loading and unloading.

Where high-speed train and conventional rail operations share a right-of-way, incompatible services must be separated horizontally or vertically. The high-speed tracks will be protected by an intrusion detection system and, in some areas, separated from conventional rail operations by a crash barrier, or by elevating the high-speed train infrastructure.