California-Nevada Interstate Maglev Project

M. Neil Cummings, American Magline Group
11150 West Olympic Boulevard, Suite 1050, Los Angeles, CA 90064-1817, USA
310.914.1849/fax 310.914.1853, mncassoc@aol.com
Bob Baldi, General Atomics
San Diego, CA 92186-5608, USA
Larry Blow, Transrapid International-USA
Washington, DC 20004, USA
Jim Caviola, Parsons Corporation
Las Vegas, Nevada 89119 USA
Hong Chin, Citigroup Global Markets Inc
San Francisco, CA 94104 USA
Wendall W. Hirschfeld, Hirschfeld Steel Co. Inc.
Austin, Texas 78701 USA
Richann Johnson, California-Nevada Super Speed Train Commission
Las Vegas, NV 89101 USA
Gui Shearin, Parsons Corporation
San Francisco, CA 94105 USA
Guillaume.Shearin@parsons.com

Acknowledgements

This paper summarizes project descriptions and plans prepared by the California-Nevada Super Speed Train Commission and the American Magline Group with federal matching funds from the U.S. Department of Transportation as part of the Maglev Deployment Program and continuing funding under the United States Transportation Equity Act of the 21st Century.

Keywords

Alignment Optimization, Maglev, IGBT Propulsion, Robotics, Bond Financing

Abstract

As part of the United States Transportation Equity Act of the 21st Century, the American Magline Group under the sponsorship of the Federal Railroad Administration is pursuing the California-Nevada Interstate Maglev Project. The local public sponsor is the California-Nevada Super Speed Train Commission. This 432 km (268 mi) project would connect Anaheim, California and Las Vegas, Nevada using high-speed maglev. The proposed maglev system would achieve top speeds of 500 km/h (311 mph), with an express time of 87.5 minutes from Anaheim to Las Vegas, corresponding to an average speed of 288 km/h (179 mph). Projected ridership in 2025 would be 42.8 million trips per year, including 14 million annual intercity trips between California and Nevada and 28.8 million annual suburban trips at the urban ends of the maglev line. The financial plan for first 56-km (35-mile) segment from Las Vegas to Primm includes federal funding in conjunction with private sector bond financing.

1 Introduction

1.1 Background

The California-Nevada Super Speed Train Commission was formed in 1988 to promote the development of, and issue a franchise to build, a 432-km (268-mi) super speed train system connecting Las Vegas with Anaheim and other points in Southern California, now known as the California Nevada Interstate Maglev Project (CNIMP). The Commission in 1991 selected the *Transrapid*™

Maglev technology as the ideal high speed ground transportation system for this corridor. In 1998, as part of the Transportation Equity Act for the 21st Century, the Maglev Deployment Program was enacted by the U.S. Congress in order to plan, build, and demonstrate a high speed maglev system in an appropriate location somewhere in the United States. The program was run as a competition among state sponsors and their designated public agencies. The Commission and its private sector partner, the American Magline Group (AMG), entered the competition with the “First Forty Miles” of the CNIMP, the segment between the Las Vegas South Corridor Resort (SCR) and the town of Primm, on the California border. It received federal matching funds to prepare a project description and plans for this segment [1]. The AMG is a joint venture consisting of General Atomics, Parsons Corporation, Hirschfeld Steel Company, and M. Neil Cummings & Associates. Even though the project was estimated to be by far the least expensive and the easiest to build among those in the competition, it was not among the two selected by the U.S. Department of Transportation (DOT) in early 2001 for a later stage in the competition that is now still underway. Congress, however, has continued to appropriate additional funding for the project that has been used to prepare preliminary plans for the remainder of the project and to begin environmental analysis and documentation for the project [2, 3, 4, and 5].

1.2 Project Overview

Figure 1 depicts the proposed maglev project between Anaheim, California, and Las Vegas, Nevada. The project would provide safe, reliable, environmentally benign, and rapid transportation between two fast growing and heavily populated regions of the U.S., the Las Vegas area and Southern California.

Figure 1: Proposed California-Nevada Interstate Maglev Project

The project would have six stations: the cities of Anaheim, Ontario, Victorville, and Barstow in Southern California, the town of Primm on the Nevada border, and the City of Las Vegas. It would be constructed in three phases as noted below, with the timing depending upon funding availability. The last phase would be constructed from the Ontario and Primm ends to meet at Barstow. A 12.1-km (7.1-mi) connection from the SRC Station at the south end of the “Strip” to Downtown Las Vegas would also be constructed in the last phase, for a total project length of 431.9 km (268.4 mi).

The planned construction phases include:

- Phase 1: Las Vegas – Primm:
- Phase 2: Anaheim – Ontario
- Phase 3: Ontario – Barstow – Primm – SRC – Downtown Las Vegas

2 Speed Profile and Operational Characteristics

Figure 2 displays the speed profile based on the alignment and operation parameters for local service on 20-minute headways between Anaheim and the SRC Station in Las Vegas. The speed profiles are computed separately for rides in both directions: the eastbound profile is blue, and the westbound profile is red. The speed limit constraints are due to curves.

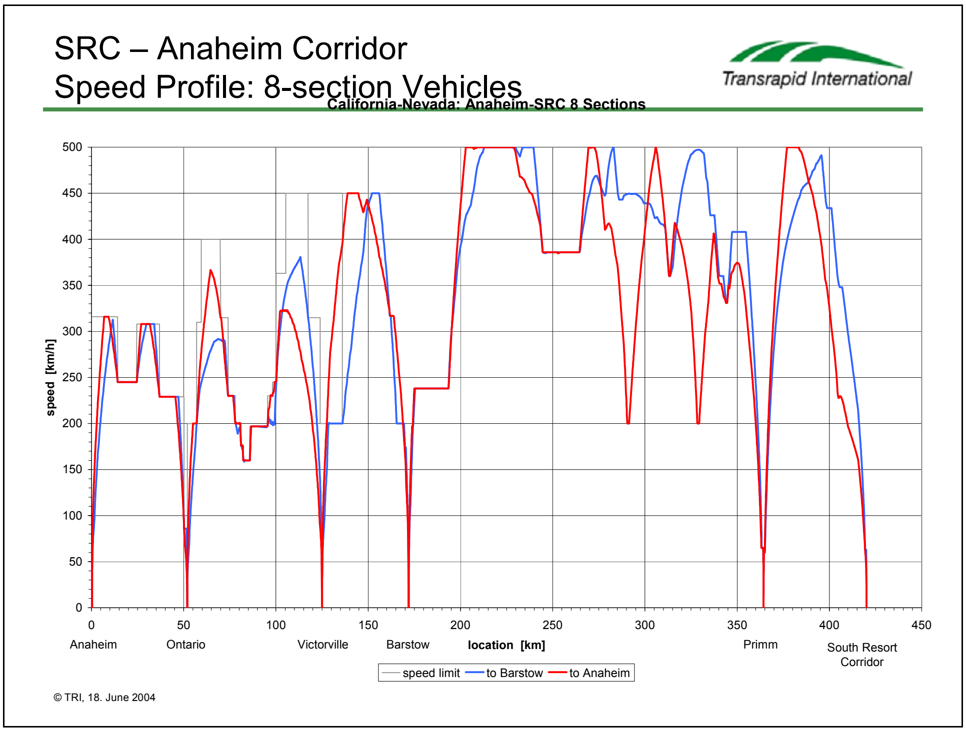


Figure 2: Speed Profile between Anaheim and Las Vegas (SRC Station)

Peak speeds of 500 km/h (311 mph) are possible in both the SRC-Primm and Primm-Barstow segments of the SRC-Anaheim corridor. Between Barstow and Victorville, speeds of 450 km/h (280 mph) can be reached; between Victorville and Ontario corridor trains can reach speeds of up to 430 km/h (267 mph). In the Ontario-Anaheim segment, service can reach speeds of 320 km/h (199 mph), constrained by the more urban location of the alignment. All segments of the Anaheim-SCR corridor effectively utilize alignment features unique to Transrapid, including its ability to climb up to 10-percent grades and use up to 12-degrees of cant (superelevation) to allow higher speeds through curves. Average speed in express service from Anaheim to SRC-Las Vegas would be 288 km/h (179 mph), which includes a stop in Ontario.

Figure 3 illustrates the operations and trains scheduling for the entire corridor. Planned headways would be 10 minutes (six trains per hour each way) between Anaheim and Ontario and 20 minutes between Ontario and Las Vegas (three trains per hour each way). Dotted boxes indicate the portions of the corridor where single-track guideway is possible and has been used.

Table 1 summarizes the service and route characteristics for the two initial segments and intercity corridor between Anaheim and Las Vegas. The two initial segments would operate as stand alone segments with local service in the initial phases of the project. Current operations are based on eight-section trains for intercity service and four-section trains for local service on the Anaheim-Ontario local service. Maximum throughput is 10,608 seated passengers per hour per direction (pphpd) for a 10-section train with 5-minute headways, which is comparable throughput to an 8-lane freeway (4-lanes in each direction).

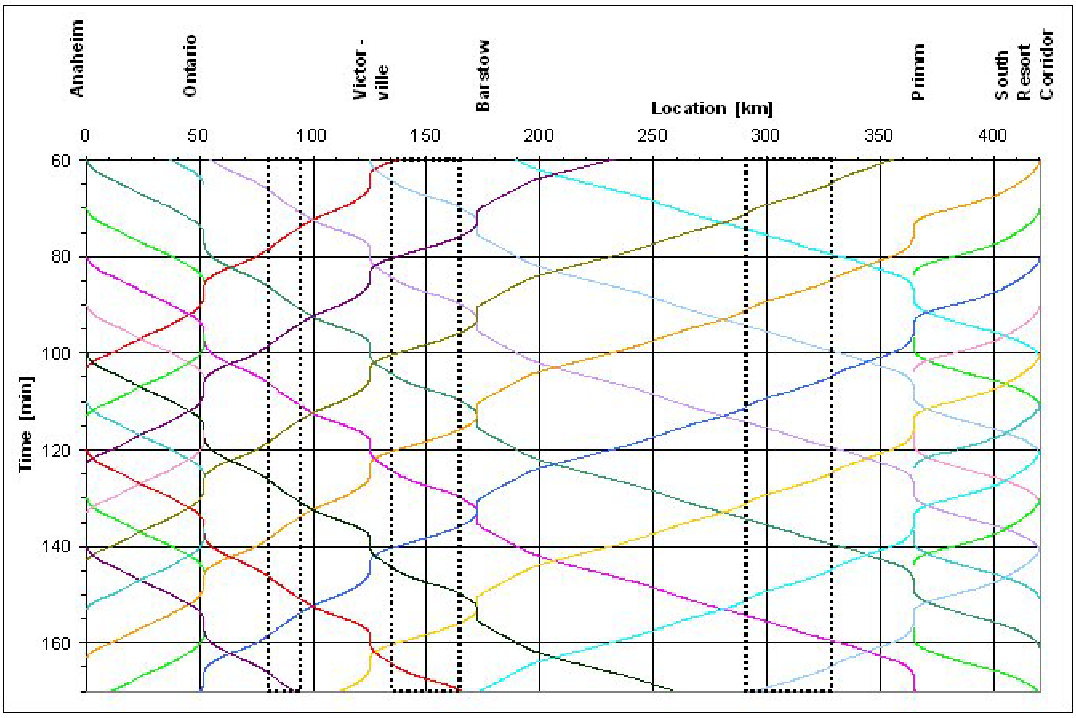
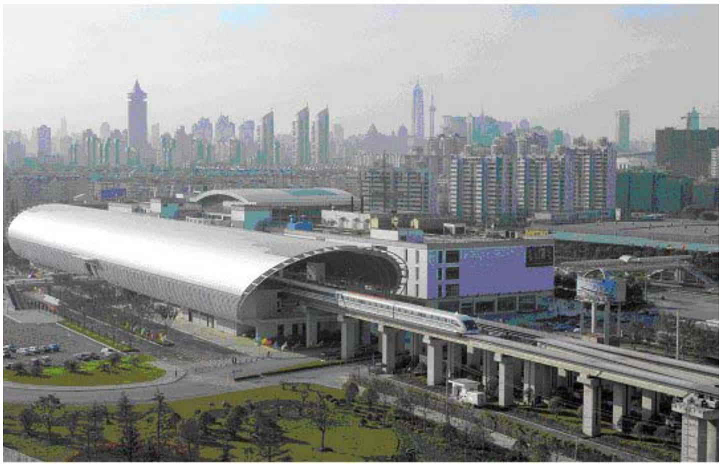


Figure 3: Corridor Operations and Scheduling

Table 1: Planned Service Characteristics for Initial Segments and SRC – Anaheim			
Operation ***Route***	**Local / Regional:** ***SRC – Primm***	**Commuter / Regional:** ***Ontario - Anaheim***	**Intercity:** ***SRC – Anaheim***
Revenue Guideway Single Track Double Track	(Initial Segment Service) 37.6 km (23.3 mi) 18.2 km (11.3 mi)	(Initial Segment Service) 0 km 51.6 km (32.0 mi)	(Full Corridor) 120 km (74.4 mi) 299.8 km (185.9 mi)
Trip Time	14.5 / 12 minutes	14.5 / 14.5 minutes	87.5 minutes express
Operating Headway	20 minutes	10 minutes	20 minutes
Operating Period	6:00 – 1:00 (19 hours)	6:00 – 1:00 (19 hours)	6:00 – 1:00 (19 hrs)
Trips per day	114 (one-way trips)	228 (one-way trips)	114 (one-way trips)
Vehicle Fleet	8-section trains 2 Trainsets + 1 Spare (initial operation)	4-section trains 5 Trainsets + 1 Spare (initial operation)	4- & 8-section trains 3 + 12 Trainsets + 3 Spares
Vehicle Capacity-Seated Seated/Standing	639 passengers 1101 passengers	305 passengers 535 passengers	639 passengers 1101 passengers
Transportation Capacity: Seated pphpd: Seated/standing pphpd:	1917 3303	1830 3210	1917 3303
Maximum Future Capacity Seated pphpd Seated/Standing pphpd	10608 17544	10608 17544	10608 17544

3 Technical Innovations



Transrapid International is providing the base technology, vehicles, and controls, with lessons learned from the Emsland Test Facility and especially recent Shanghai experience. The deployment of *Transrapid* technology in Shanghai, China, is the first commercial application of high-speed Maglev in revenue service. The 30-kilometer (19.5-mile) connection features a normal operating speed of 430 km/h (267 mph), although a test in November 2003 reached a top speed of 501 km/h (311 mph).

Figure 4: Transrapid in Shanghai

Hirschfeld Steel Corporation is developing manufacturing plans that envision a mass-production assembly line operation using advanced computer and robotics technology. Specialized plants would be built to fabricate the steel girders. Steel plate would be cut to size into segments, or components, of the girders and positioned for precision robotic welding. The temperature extremes of the high desert environment for the CNIMP alignment pose design challenges for maintaining tolerances in the steel girders. The required amount of steel is significant in terms of national jobs and output of U.S. steel industry, amounting to four percent per year of US steel output over the 10-year construction period for the complete project.

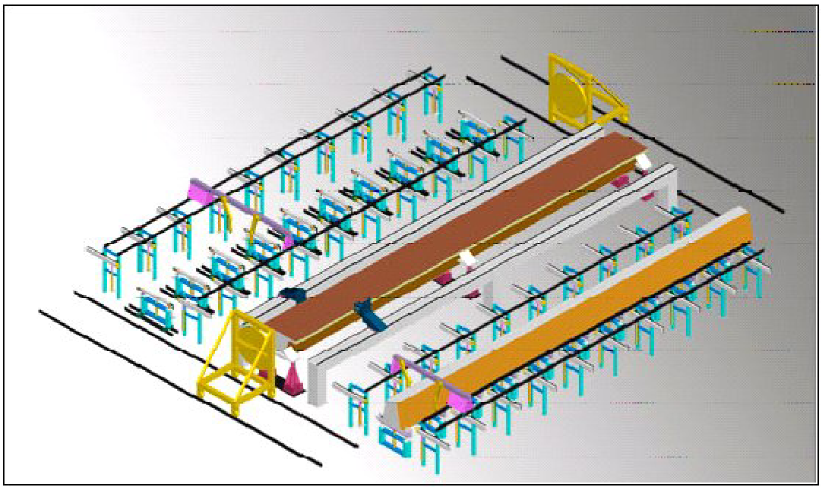


Figure 5: Assembly Device for Steel Girders

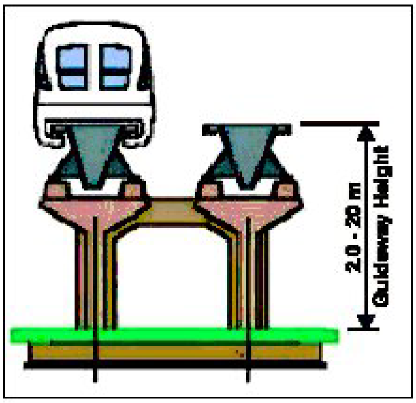


Figure 6: Type I Elevated Guideway

Parsons is developing the alignment including optimization to minimize cost. In constrained areas, such as the Cajon Pass between Ontario and Victorville, analysis techniques provided by Quantum, a firm highly skilled in alignment optimization, will be utilized. The majority of the California alignment will be on elevated guideway (Type I), which accommodates variations in terrain or avoids urban conflicts using either single- or double-column structures. Construction in California will require seismic reinforced structures to meet seismic requirements, with deep foundations estimated to be needed for 40 percent of the California alignment.

The majority of the Phase 1 alignment between Las Vegas and Primm will be at-grade Type III guideway in flat desert terrain. Figure 7 illustrates the terrain and traffic along I-15 at Jean, where several casinos and a general aviation airport constitute the only urban features between the edge of Las Vegas and Primm.

Figure 7: Desert Terrain and Traffic along I-15 between Las Vegas and Primm, Nevada

General Atomics is developing advanced power electronics systems to improve train propulsion. These innovative systems are based on the insulated gated bi-polar transistor technology (IGBT). IGBT propulsion systems are currently being developed for other electro-magnetic propulsion systems such as the Electro-Magnetic Aircraft Launch Systems for new aircraft carrier designs. The new IGBT power electronics were selected over the existing gate-turn-off (GTO) technology for Maglev due to improved operational performance, reduced cost, and simpler, less costly gate-drive circuits. General Atomics is also developing plans to provide the energy supply for the CNIMP. They are supported by Power Consultants of Glendora with in-depth knowledge of the Southern California electric utility grid system.

Figure 7: IGBT based Converter System

Citigroup Global Markets Inc. is developing the financing plans for the CNIMP. The financial plan includes Federal funding in conjunction with private sector bond financing for the initial Las Vegas to Primm segment. It is expected that operating profits will be sufficient to provide for a major part of the costs of future expansion of the system.

4 Benefits and Costs

Table 2 summarizes the estimated ridership, fares, average net operating revenue, capital costs, and benefits for the two initial segments and the cumulative SRC to Anaheim corridor. Ridership forecasts project a total ridership of 42.8 million riders per year in 2025, ten years after the planned opening of the entire maglev system in 2015. Average annual net operating revenue is projected to range from

$49 million per year for the initial Primm segment to $517 million per year for the SRC to Anaheim segment. Capital costs are estimated to be $1.3 billion (2000 $) for the initial SRC-Primm segment and about $12 billion for the SRC to Anaheim system (2000 $).

Table 2: Projected Ridership, Costs, and Benefits for Initial Segments and SRC to Anaheim

Operation ***Route***	**Local / Regional:** ***SRC – Primm***	**Commuter / Regional:** ***Ontario – Anaheim***	**Intercity:** ***SRC - Anaheim***
Projected Annual Ridership in 2025	(Initial Segment Service) 14.3 million	(Initial Segment Service) 13.9 million	(Full Corridor) 42.8 million
Fares (2000 $)	$4 to $6	$9	$55 intercity, $4-$6 local Nevada, $9 - $12 local California
Average Annual Net Operating Revenue (2000 $)	$49.2 million	$86.6 million	$517.4 million
Capital Costs (2000 $)	$1.3 billion	$2.6 billion	$12.1 billion
Benefit/Cost Ratio	1.5	1.7	1.8

Figure 8 summarizes the breakdown of the present value of benefits for the complete SRC to Anaheim corridor using a seven percent discount rate over a 41-year study period. Revenue and consumer surplus would make up about two thirds of the benefits. Consumer surplus measures the travel efficiency benefits which users receive but do not pay for. The remaining benefits would accrue to the public in the form of reduced delays in highway and air travel between Las Vegas and Southern California resulting from diversion to maglev. Reduced highway fatalities would also add slightly to the public benefits as a result of reducing intercity automobile traffic.

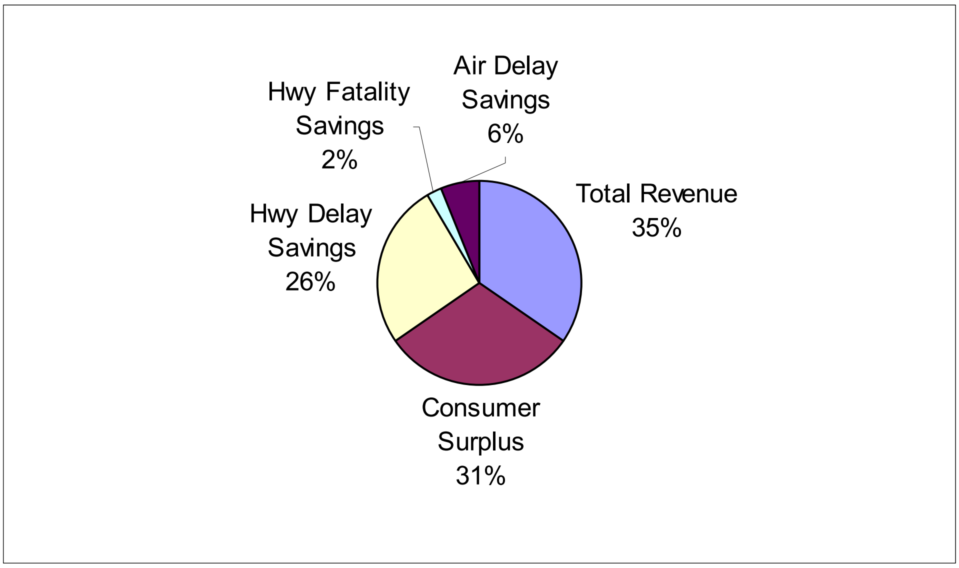


Figure 8: Breakdown of Present Value of Benefits of Full Corridor SRC – Anaheim 2009 – 2049

At the discount rate of seven percent, the benefit/cost ratio of the full corridor from SRC to Anaheim maglev over the 41-year study period would be 1.8. The benefit/cost ratios of the initial segments would be 1.5 for SRC to Primm and 1.7 for Anaheim to Ontario, showing that the project would return more than adequate benefits to justify the expenditure of the construction costs. The project would return enough net revenue to finance a major share of the construction costs. It would also generate additional environmental benefits of savings in energy consumption, improvement in air quality, and positive land use changes.

5 Public-Private Partnership for Innovative Techniques

The organizational arrangement and American Magline Group (AMG) team structure is as follows.

- California-Nevada Super Speed Train Commission—Public Partner
  - American Magline Group—Private Partner (Joint Venture Members)
    - General Atomics
    - Parsons Corporation
    - Hirschfeld Steel Co.
    - M. Neil Cummings & Associates
  - American Magline Group—Private Partner (Subcontractors)
    - Booz-Allen Hamilton
    - Citigroup Global Markets Inc.
    - Transrapid International-USA, Inc.
    - URS Corporation

The Commission and AMG have an exclusive arrangement through the finance, construction, operation, and maintenance phases.

References

1. California-Nevada Super Speed Train Commission and American Magline Group. *California-Nevada Interstate Maglev System, Las Vegas to Primm Segment, Project Description,* Prepared for Federal Railroad Administration, June 2000.
2. California-Nevada Super Speed Train Commission and American Magline Group. *California-Nevada Interstate Maglev System, Las Vegas to Barstow Segment, Project Description,* Prepared for Federal Railroad Administration, September 2002.
3. California-Nevada Super Speed Train Commission and American Magline Group. *California-Nevada Interstate Maglev System, Anaheim to Ontario Segment, Project Description,* Prepared for Federal Railroad Administration, September 2003.
4. California-Nevada Super Speed Train Commission and American Magline Group. *California-Nevada Interstate Maglev System, Ontario to Barstow Segment, Project Description,* Prepared for Federal Railroad Administration, February 2004.
5. California-Nevada Super Speed Train Commission and American Magline Group. *Draft California-Nevada Interstate Maglev System, Las Vegas to Anaheim Segment, Project Description,* Prepared for Federal Railroad Administration, June 2004.