California-Nevada Interstate Maglev Project (CNIMP)

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ABSTRACT: The California-Nevada Super Speed Train Commission (CNSSTC) and the American Magline Group (AMG) are proceeding with planning for the construction of the Las Vegas to Primm Maglev Project. This 56-km (35-mile) segment from Las Vegas to Primm is the first step of the full corridor California-Nevada Interstate Maglev Project (CNIMP), which will be a 432 km (268 mi) project connecting Anaheim, California and Las Vegas, Nevada using high-speed Maglev with top speed capability of 500 km/h (311 mph).

1 INTRODUCTION

1.1 Background

The CNSSTC was formed in 1988 to promote the development of, and issue a franchise to build, a 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*™ (TRI) Maglev technology as the ideal high-speed ground transportation system for this corridor.

TRI Maglev (shown in Figure 1) was selected because its high speed and acceleration resulted in higher projected passenger throughput than conventional wheel-on-rail system with greater operating profit potential.

Figure 1: Transrapid Maglev Technology Selected for CNIMP

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 CNSSTC 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]. Congress continued to appropriate additional funding for the project 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].

In 2005, Congress approved the new transportation bill entitled Safe, Accountable, Flexible, Efficient Transportation Equity Act – A Legacy for Users (SAFE-LU). This bill allocated $45M to initiate deployment of the Las Vegas to Primm project segment.

1.2 Project Overview

Figure 2 depicts the proposed full corridor Maglev project located in the southwestern United States between Anaheim, California, and Las Vegas, Nevada. The project will 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 2: California-Nevada Interstate Maglev Project (Full Corridor)

The project will 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. Construction is planned in three phases as noted below, with the timing dependent upon funding availability. The last phase will be constructed from the Ontario and Primm ends to meet at Barstow. Total project length is 432km (268 mi).

The planned construction phases include:

- Phase 1: Las Vegas – Primm: 55.8 km (34.7 mi)
- Phase 2: Anaheim – Ontario: 51.6 km (32.1 mi)
- Phase 3: Ontario – Barstow – Primm – Las Vegas (SRC) – Downtown Las Vegas: 324.5 km (201.6 mi)

2 SPEED PROFILE AND OPERATIONAL CHARACTERISTICS

Peak speeds of 500 km/h (311 mph) are possible in both the Las Vegas-Primm and Primm-Barstow segments of the Las Vegas (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 is limited to 320 km/h (199 mph), constrained by the more urban location of the alignment. All segments of the Anaheim to Las Vegas corridor effectively utilize alignment features unique to Transrapid, including its ability to climb up to 10 percent grade and use up to 12-degrees of cant (super elevation) to allow higher speeds through curves. Average speed in express service from Anaheim to Las Vegas will be 288 km/h (179 mph), which includes a stop in Ontario.

Table 1 summarizes the service and route characteristics previously studied for the two initial segments and intercity corridor between Anaheim and Las Vegas. As shown, these studies were based on the passenger station for Las Vegas being located at the south resort corridor (SCR). Future studies will incorporate updated characteristics including revising the Las Vegas passenger station to be located in downtown Las Vegas. The two initial segments (Las Vegas to Primm & Ontario to Anaheim) will operate as stand-alone segments with local service in the initial phases of the project. Operations were based on eight-section trains for intercity service and four-section trains for local service on the Anaheim-Ontario segment. 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).

Table 1: Planned Service Characteristics for Initial Segments and Las Vegas (SRC) – Anaheim

Operation	Local/Regional:	Commuter/Regional:	Intercity:
Route	*Las Vegas (SRC) – Primm*	*Ontario - Anaheim*	*Las Vegas (SRC) – Anaheim*
Revenue Guideway	(Initial Segment Service)	(Initial Segment Service)	(Full Corridor)
Track	37.6 km (23.3 mi)	0 km	120 km (74.4 mi)
Double Track	18.2 km (11.3 mi)	51.6 km (32.0 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	0600-0100 (19 hours)	0600-0100 (19 hours)	0600-0100 (19 hrs)
Trips per day	114 (one-way trips)	228 (one-way trips)	114 (one-way trips)
Vehicle Fleet	8-section trains	4-section trains	4- & 8-section trains
	2 Train sets + 1 Spare (initial operation)	5 Train sets + 1 Spare (initial operation)	3 + 12 Train sets + 3 Spares
Vehicle Capacity-Seated	639 passengers	305 passengers	305 & 639 passengers
Seated/Standing	1101 passengers	535 passengers	535 & 1101 passengers
Transportation Capacity:			
Seated pphpd:	1917	1830	1917
Seated/standing pphpd:	3303	3210	3303
Maximum Future Capacity			
Seated pphpd	10608	10608	10608
Seated/Standing pphpd	17544	17544	17544

*** Note:** Previous studies were based on the Las Vegas passenger station located in the area of the south resort corridor. Future studies will revise the above characteristics to reflect a downtown location for the Las Vegas passenger station.

The projected ridership for 2025 for the Las Vegas to Primm segment and the full corridor from Las Vegas to Anaheim is 14.3 and 42.8 million (one-way) trips, respectively.

3 TECHNICAL INNOVATIONS

TRI is providing the base technology, vehicles, and controls, with lessons learned from the Emsland Test Facility and more importantly from the recent Shanghai experience (Figure 3). 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).

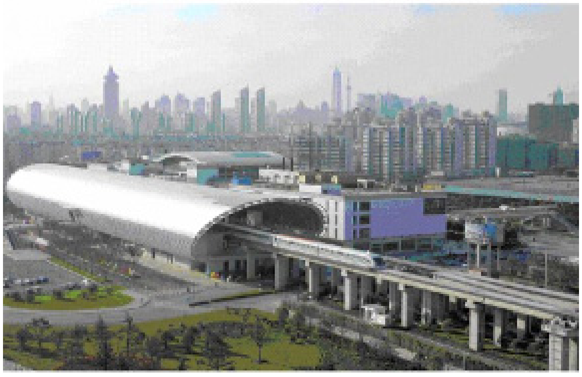


Figure 3: Transrapid in Shanghai

Hirschfeld Steel Corporation is developing manufacturing plans that envision a mass-production assembly line operation using advanced computer and robotics technology (Figure 4). Specialized plants will be built to fabricate the steel girders. Steel plate will 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. Total output of steel is significant in terms of creating national jobs and increasing output of the U.S. steel industry, amounting to four percent per year of U.S. steel output over the 8-year construction period for the complete project.

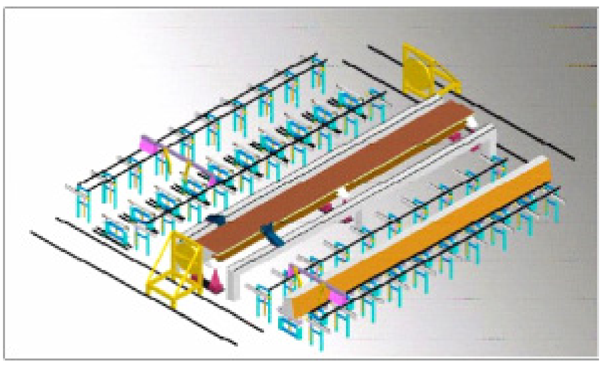


Figure 4: Mass Production for Steel Girders

Parsons is developing the alignment including optimization factors 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 (Figure 5). Construction in California will require reinforced structures to meet seismic requirements, with deep foundations needed for 40 percent of the California alignment.

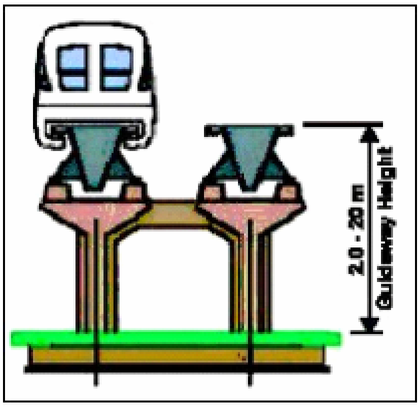


Figure 5: Type I Elevated Guideway

The majority of the Phase 1 alignment between Las Vegas and Primm will be at-grade Type III guideway in flat desert terrain. Figure 6 illustrates the terrain along I-15 at Jean, where casinos and a general aviation airport constitute the main features between the edge of Las Vegas and Primm.

Figure 6: Desert Terrain between Las Vegas and Primm

General Atomics (GA) is developing advanced power electronics systems to improve train propulsion (Figure 7). These innovative systems are based on the insulated gated bi-polar transistor technology (IGBT). IGBT propulsion systems are currently being developed for other electromagnetic 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, and simpler, less costly gate-drive circuits. GA is also developing plans to provide the energy supply for the CNIMP. GA is supported by Power Consultants of Glendora with in-depth knowledge of the local electric utility grid system.

Figure 7: IGBT-based Advanced Power Electronic 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.

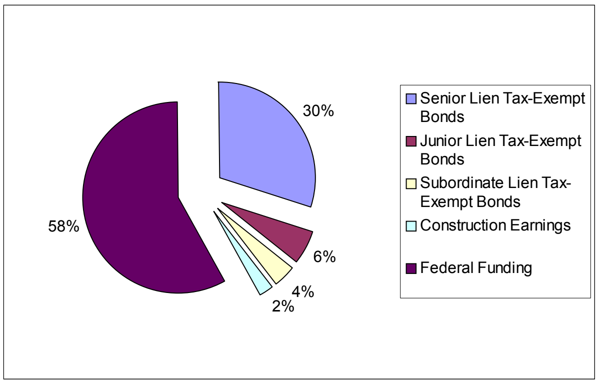
4 BENEFITS AND COSTS

Table 2 summarizes the estimated ridership, fares, average net operating revenue, capital costs, and benefits for the two initial segments and the cumulative Las Vegas (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

Table 2: Projected Ridership, Costs, and Benefit-to-Cost Ratio

Operation	Local/ Regional:	Commuter/ Regional:	Intercity:
Route	*Las Vegas (SRC) – Primm*	*Ontario – Anaheim*	*Las Vegas (SRC) - Anaheim*
Projected Annual Ridership in 2025	(Initial Segment Service)	(Initial Segment Service)	(Full Corridor)
	14.3 million	13.9 million	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

range from $49 million per year for the initial Primm segment to $517 million per year for the Las Vegas (SRC) to Anaheim segment. Capital costs are estimated to be $1.3 billion (2000 $) for the initial Las Vegas (SRC)-Primm segment and about $12 billion for the Las Vegas (SRC) to Anaheim system (2000 $). Planned funding sources are provided in Figure 8.



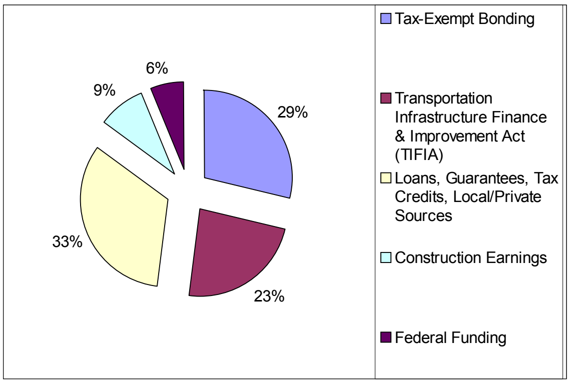


Figure 8: Funding Source for Las Vegas - Primm (top) and Las Vegas - Anaheim (bottom)

Figure 9 summarizes the breakdown of the present value of benefits over the life of the project for the complete Las Vegas (SRC) to Anaheim full corridor. Revenue and consumer surplus makes up about two thirds of the benefits. Consumer surplus measures the travel efficiency benefits that users receive but do not pay for. The remaining benefits

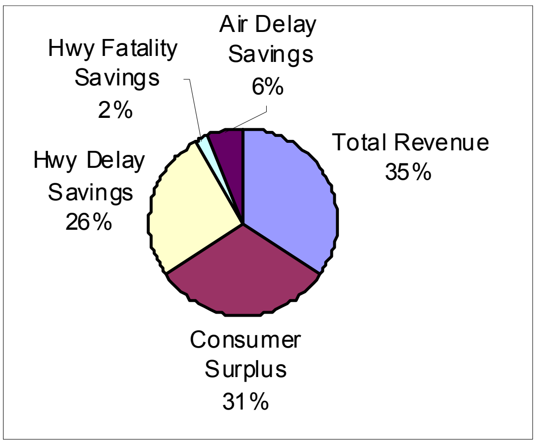


Figure 9: Breakdown of Present Value of Benefits of Full Corridor Las Vegas (SRC) – Anaheim 2009 – 2049

will 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 will also add to the public benefits as a result of reducing intercity automobile traffic. At the discount rate of seven percent, the benefit/cost ratio of the full corridor from Las Vegas (SRC) to Anaheim Maglev over the 41-year study period is 1.8. The benefit/cost ratios of the initial segments is 1.5 for Las Vegas (SRC) to Primm and 1.7 for Anaheim to Ontario, showing that the project will return more than adequate benefits to justify the expenditure of the construction costs. The project will return enough net revenue to finance a major share of the construction costs. It will also generate additional environmental benefits of savings in energy consumption, improvement in air quality, and positive land use changes.

5 PUBLIC-PRIVATE PARTNERSHIP

The Commission and AMG have an exclusive arrangement covering the finance, construction, operation and maintenance phases for the CNIMP. Roles and responsibilities of all major participants are shown in Table 3.

Table 3: CNIMP Organizations, Roles, and Responsibilities

Participant	Responsibilities
FRA	Administration. Sponsor for PEIS/EIS and safety certification (Rule of Particular Applicability).
CNSSTC	State Agency. Public Partner. Local coordination and public outreach.
NDOT	State Agency: Lead agency for PEIS/EIS.
Caltrans	State Agency: Coordinating agency for PEIS.
American Magline Group	CNSSTC Private Partner. Prime contractor. Technology transferee. Project Management. Support local coordination and public outreach.
M. Neil Cummings & Associates	Project Management.
Transrapid-USA	Technology provider. Technology transferor. Systems architecture and analysis. Vehicle propulsion and control system engineering.
General Atomics	Energy supply and propulsion system. (Industrial Partner)
Hirschfeld Steel	Guideway. (Industrial Partner)
Parsons	Project planning, civil engineering, and benefits analysis. Seed alignment and right-of-way. Civil structures and passenger stations. (Industrial Partner)
Citigroup	Financial Plans.

The AMG will approach the design and construction of the Project as a design and build venture. Parsons Corporation has been the design partner in a series of design-build projects, including the San Joaquin Hills Corridor (Toll Road) in Orange County, California; Yosemite Valley/Route 120 Reconstruction, and others. The design-build has great potential for realizing up to 25 percent cost reduction and a much shorter time schedule than traditional contracting methods. For example, the first segment in Southern Nevada area is well suited to design-build because the flat, uncomplicated terrain lends itself to fast, efficient construction techniques with few, if any complicating environmental issues.

Such an approach also includes risk sharing, in which the private side takes on schedule and cost risk normally born by the public side. This arrangement, coupled with the flexibility and control that design-build can bring, creates strong incentives for cost and schedule reduction. Also as a world leader in transit system design and construction oversight (e.g., the DC Metro), Parsons Corporation is committed to an innovative, cost-effective delivery of the Maglev system.

The roles of Hirschfeld Steel and General Atomics also bring innovation to the design and construction of the Project. With their respective expertise in steel fabrication and electromagnetic propulsion integrated from the early planning stages of the project, the AMG is poised to develop cost-effective applications of the Transrapid Maglev technology.

Two major subcontractors support the AMG: Transrapid International-USA, Inc and Citigroup Global Markets Inc. Transrapid International-USA supports AMG through a technology-sharing agreement and is the provider of the basic Maglev technology. Citigroup brings financing expertise to the AMG, having recently conducted the bond sales used to finance the Las Vegas monorail, which opened for service in 2004.

6 KEY STEPS LEADING TO CONSTRUCTION

There are several key steps that are necessary to begin construction and are currently in progress:

- Completion of Programmatic Environmental Impact Study (full corridor)
- Completion of Site-specific EIS (Las Vegas to Primm)
- Obtaining Record of Decision (ROD)
- Securing construction funds authorized by U.S. Congress
- Securing balance of financing (tax-exempt bonds, loans, loan guarantees, local and private sources)
- Attaining permit approvals (See Table 4)

Once approvals are obtained, construction of the Las Vegas to Primm segment is expected to take approximately 3.3 years. Construction of the balance of the full corridor is estimated to require an additional 5 years.

Table 4: Permit Approvals (Examples)

Agency	Sample Issues
Bureau of Land Management	Use of federally owned land
U.S. Army Corps of Engineers	Stream crossings
U.S. Fish & Wildlife Service	Endangered species
Environmental Protection Agency	National Environmental Policy Act (NEPA)
Surface Transportation Board	Certificate of Public Convenience (Passenger & freight on same route)
State of Nevada/Clark County	Construction and Operation Permits

7 CONCLUSIONS

Building the CNIMP makes sense. It serves a growing need in which the benefit-to-cost ratio is very favorable. It will assist the United States in building a transportation system that meets the economic, social, quality of life, and environmental challenges of the 21st century. We need to build it now!

8 ACKNOWLEDGEMENTS

This paper summarizes project descriptions and plans prepared by the California-Nevada Super Speed Train Commission (CNSSTC) and the American Magline Group (AMG) to address the Las Vegas to Primm Nevada project authorized under the Safe, Accountable, Flexible, Efficient Transportation Equity Act – A Legacy for Users (SAFE-LU). Prior studies regarding the full corridor for the CNIMP were prepared with federal matching funds from the U.S. Department of Transportation, Federal Railroad Administration (FRA) as part of the Maglev Deployment Program funded under the United States Transportation Equity Act of the 21st Century.

9 REFERENCES

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