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Status of U.S. Maglev Program*

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ABSTRACT

Factors that have led to a reawakening of national interest in maglev technology in the United States are discussed. The development of the National Maglev program, its findings, and the four maglev design concepts resulting from the System Concept Definition study are reviewed. Technical requirements for the SCD contractors and for the Prototype Development Program are compared. Some legislative background information is given, with a review of the most important maglev legislation. Plans for the National Maglev Prototype Development Program are discussed, and activities related to maglev at Argonne National Laboratory are summarized.

KEY WORDS: Maglev, Superconductivity, Guided Ground Transportation

INTRODUCTION

Many factors have contributed to the recent growth in interest in maglev in the United States: The discovery of high-temperature superconductivity, with its potential benefits for maglev technology; the imbalance of payments; the sense that the country is losing its technological competitiveness; and the need to convert defense-related industries to civilian activities come immediately to mind. Certainly, the tremendous progress in the development of maglev technology in both Japan and Germany has shown people in the U.S. government, as well as the general public, that maglev trains are not just science fiction, but reality! The future need for more transportation capacity, with a the growing awareness that the highway and airline modes are unable to handle the ever-expanding demands for fast, efficient, economical intercity travel, has also provided strong motivation for developing alternative modes. However, unlike the case in many other countries, rail passenger service in the United States has not been competitive with other modes for many years. Consequently, significant expansion of ridership on that mode, taking the pressure off the highway and airline modes, would require major capital investments. Even modest improvements in travel time, ride comfort, and safety would require substantial investments to upgrade diesel-electric locomotives, rolling stock, railbed and track standards, signaling systems, and grade separation at crossings. And, such improvements would not necessarily divert significant ridership from the existing modes, reduce dependence on imported petroleum, or improve the environment. In addition, major infrastructure changes including better access to new or substantially renovated stations, are required to attract increased ridership. Implementing a high- speed rail (HSR) system that would divert substantially greater ridership and yield other benefits to society would probably require all-new, electrified rail lines that are completely grade-separated and dedicated to high-speed passenger service or at least maintained to much higher standards than at present.

All of these considerations were brought into focus by two pivotal reports that received wide distribution in the United States in 1989. At the request of Senator Daniel P. Moynihan, the Maglev Technology Advisory Committee (MTAC) was organized in October 1988. The deliberations of that committee culminated in the Moynihan Maglev Committee Report.[1] At that time, Argonne was already at work on the potential applications of high-temperature superconductors to transportation and on finding a suitable market niche for maglev. That work led to the Argonne maglev report,[2] which showed how, through integrating a maglev system with airline operations at airports, a significant fraction of the short-haul airline trips (those under 600 miles) could be diverted to maglev trips. The short-haul trips would include origin-destination city pairs and feeder trips to major hub airports.

THE NATIONAL MAGLEV INITIATIVE (NMI)

The budget that was approved by Congress for FY90 contained language that directed the Federal Railroad Administration (FRA) to assess the current state of the art of maglev technology, including an analysis of the economic and technical feasibility of constructing commercial maglev systems in the United States over the next 20 years and the identification of measures that could promote U.S. industry leadership in the production of such equipment. That budget's language also directed the U.S. Army Corps of Engineers (ACE) to prepare a detailed implementation plan for a national maglev program. To coordinate the activities of the FRA ,the ACE, and other interested agencies, including the U.S. Department of Energy and the U.S. Environmental Protection Agency (EPA), the Federal Maglev Executive Committee was formed. The report of that first year's efforts, published by

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for further studies was emphasized and a request for funding was included in the President's budget request for FY91. The ACE's plan was also completed and reported to Congress in June 1990 in a separate report.[4]

In FY91, the NMI initiated two major procurements: the Broad Agency Announcement (BAA) and the System Concept Definition (SCD) study. About 250 proposals were received by the NMI Office in response to the BAA published in September 1990. Of these the 27 selected for funding covered virtually every aspect of maglev technology, including levitation, guidance, propulsion, power pickup and conditioning, guideway design, superconductor applications, system-wide considerations, operational questions, and environmental impacts. The average funding level was a little over $100,000. Final reports are available from the National Technical Information Service (NTIS).

The request for proposals for the SCD study, published in February 1991, generated about a dozen proposals, of which four were selected for funding at about the $2 million level for a contract period of eleven months. The contractors were required to meet a number of technical specifications, the most important of which are listed in Table 1. "Prototype" technical requirements are also shown in Table 1. The four concepts use superconducting magnets on board the vehicles. Three use electrodynamic suspension (EDS) and one uses the electromagnetic suspension (EMS) technology. Table 2 lists some of the more technically interesting innovations incorporated in the various concepts.

During the past year, all the information acquired from the various government contracts, in-house studies, and other sources was assimilated into the final NMI report.[5] Some results were also reported in various papers presented at the Maglev'93 Conference, held at Argonne in May 1993.[6] The principal conclusions reached in the NMI report are as follows:

- U.S. industry can develop an advanced U.S. maglev system
- Developing a U.S. maglev system is economically justified
- A U.S. maglev system offers substantial benefits for U.S. industry and the U.S. work force
- A U.S. maglev system is not likely to be developed without significant federal government involvement.

The report's main recommendation is "that the Federal Government sponsor a competitive-based maglev development program to design, build, and test an advanced maglev system for subsequent implementation as an integral element of this Nation's intermodal transportation system." The report further recommends was that, with certain exceptions, the development program be implemented within the general framework of the Intermodal Surface Transportation Efficiency Act of 1991. A somewhat shorter report , released by ACE in August 1993 entitled "Maglev for the United States,"[7] documents the Corps' involvement in the NMI program.

PERTINENT LEGISLATION

Funding for federally sponsored programs generally requires both an authorization bill and an appropriations bill. Technically, authorizing legislation is required before any money can be designated for a particular purpose by Congress in an appropriations bill. The complete legislative process and the start-up of the intended new program require the cooperative efforts of both houses of Congress and the executive branch of the federal government. Of the many pieces of legislation pertaining to maglev and/or high-speed rail that have been proposed in Congress, few have survived the complete process. Some of the most important bills are noted here:

1. *The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991.* Passed by Congress on November 27, 1991, it authorized the National Magnetic Levitation Prototype Development Program." It is the policy of the United States to establish in the shortest time practicable a United States designed and constructed magnetic levitation transportation technology capable of operating along federal-aid highway rights-of-way, as part of a national transportation system of the United States."[8] This program is "to be managed by a program director appointed jointly by the Secretary (of the DOT) and the Assistant Secretary of the Army for Civil Works."[8] "The Secretary and Assistant Secretary shall establish a national maglev joint project office,"[8] The legislation specified a three-phase program with cost-sharing provisions, which is summarized and compared with an alternative program plan in Table 3. (The alternative plan is discussed below.) The ISTEA legislation also contained some important additional provisions. First, the program would be funded with $500 million from the Highway Trust Fund, and $225 million from general revenues. An additional $25 million from general revenues was authorized for expenditure on national high-speed ground transportation (HSGT) R&D. Second, it requires the Secretary to authorize a state (i.e., a tate government) to make federal-aid highway right-of-way available with or without charge to a publicly or privately owned authority or company for passenger or commuter rail (including HSR)

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2. *Section 13121 of House Resolution 2264* . Effective January 1, 1994. It lifts the existing restrictions on states seeking to finance HSGT projects with tax-exempt bonds. This is viewed as a potentially significant

boost to proposed HSGT projects. Although technically, the 25% limitation remains on tax-exempt bonds issued for privately financed projects, this is not regarded as a crippling provision.

RECENT BUDGET ACTION

In spite of valiant efforts on the part of special interest groups in support of the National Maglev Prototype Development Program, the House zeroed out the appropriation for FY94 in September. However, maglev was not singled out in this action. Other noteworthy programs that received little or no appropriations from the House included HSR (received only $3.5 million out of $111 million requested), the Integral Fast Breeder Reactor (IFR) Program, and the Superconducting Super Collider (SSC). On the other hand, the Senate appropriated $27.9 million for maglev (as requested by the president and $79.2 million for HSR. The Senate/House Budget Conference Committee, meeting on October 8th, granted $20 million for maglev R&D and only $3.5 million for HSR. Full funding was restored for the IFR and the SSC.

A request for $22 million for maglev R&D was successfully inserted into the DOD House Appropriations Bill this fall, according to a recent news article.[9] It was cleared by the House but has not yet been acted upon by the Senate or the Conference Committee. It is not known if the Advanced Research Projects Agency (ARPA) or some other agency would administer these funds.

PLANNING A PROPOSED NATIONAL MAGLEV PROTOTYPE DEVELOPMENT PROGRAM

Members of the NMI staff investigated alternative strategies for implementing a prototype development program. The recommended plan described in the final NMI report differs from the plan specified in the ISTEA legislation (see Table 3). Basically, the recommended plan involves fewer participants, but it allows more time for each of the three program phases. It is believed that such a strategy will more effectively manage the program's development risks while allowing greater time for the contractors to develop more innovative designs and also to provide more convincing proof-of-concept testing in the initial phases and later, more complete performance testing of individual subsystems, systems, and integrated system designs. The proposed plan also calls for a supporting R&D program that will be run in parallel with the main prototype development program, focusing on those technical areas that are likely to make maglev technology more cost-effective through reduced capital and operating costs and improved technical performance. A similar R&D program was specified in the ISTEA legislation, but it included both maglev and HSR developments.

This proposed prototype development plan is preliminary, in that it was developed before the appropriation legislation was in place. Once the final legislative language is in place and a National Maglev Prototype Program Office has been established, at least some of the proposed program plans may change.

THE ROLE OF ARGONNE

Up to this point, the role of Argonne has been to provide technical support to the NMI Office and to conduct supporting R&D. The R&D activities have included the following:

1. Conduct small-scale laboratory experiments to help evaluate maglev concepts and to provide data bases for computer code validation.
2. Develop and validate computer codes by means of data obtained from small-scale laboratory experiments. These computer codes are used to compute electromagnetic fields and forces in both attractive- and repulsive-force maglev systems, including continuous-sheet and discrete-coil guideway conductor systems. Computer codes have also been developed and tested that will be used to evaluate vehicle/guideway dynamic interactions and vehicle dynamic stability.
3. Help develop and evaluate levitation, guidance, propulsion, damping, and electromagnetic field shielding designs by means of computer codes.
4. Conduct laboratory experiments to investigate biological effects of electromagnetic fields.
5. Assess the potential markets for advanced transportation technologies, including electric highway vehicles, high-speed rail, and maglev.
6. Evaluate and compare the national impacts (such as jobs) and the public benefits (such as reduction of pollution emissions, and energy and petroleum use) of implementing alternative new transportation technologies.
7. Design large-scale maglev development and test facilities.

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STATUS OF SPECIAL PROJECTS

Many maglev development, demonstration, and commercial projects have been proposed to both federal and state governments over the past several years. Some recently proposed projects are described below:

1. The Florida Department of Transportation (FDOT) has received proposals from several organizations, including Magneplane International, H. Kolm, President; American Composite Maglev Consortium, J. Morena, Executive Director and G. Danby and J. Powell, Technical Directors; Park Square Consultants, T. Morris, President; and American Magline Group (see below). None of these proposals have been funded to date. Maglev Transit, Inc., has terminated its joint venture with Transrapid International after failing to reach a commercial agreement on the 14-mile maglev demonstration in Orlando, Florida. The FDOT has granted Maglev Transit's request to modify its plan and seek a new partner, HSST Development Corp. of Japan. They are currently preparing a new proposal to the state. The $97 million originally authorized by the ISTEA is still being held by the Federal Highway Administration for this project. The HSST Development Corp. of Japan has received certification from the Japan Ministry of Transportation for commercial operation of the HSST technology.
2. The California-Nevada Super-Speed Train Commission has received reauthorization to continue developing an HSGT line between Las Vegas and Southern California. The commission's first meeting will be held this fall. It is not known what approach the commission will take in developing the high-speed link.
3. The American Magline Group was recently formed by four principal partners: Thyssen Henschel, Booz Allen & Hamilton, Inc., Hughes Aircraft, and General Atomics. This group plans to market its technology throughout the world. Specific U.S.-proposed projects include demonstrations involving Orlando Airport , Pittsburgh , and Los Angeles International Airport (LAX) - Palmdale. The LAX - Palmdale route, proposed to the State of California, is 71 miles long and serves 13 stations with a double guideway system.
4. New York 's government has become increasingly serious about the implementation of maglev technology in partnership with the private sector. The recently completed second phase of a two-phase study comparing HSGT technologies found maglev to be economically very attractive, particularly if a regional network serving major cities in neighboring states could eventually be implemented. The state has been working cooperatively with Massachusetts on an alternative to the existing NEC route that would connect Boston, Albany, and New York City and would utilize Massachusetts and New York state highway rights-of-way. New York State has also been working with a consortium led by Grumman Corp. on a proposal to ARPA to build a maglev test track at Stewart Airport in Newburgh, New York.

CONCLUSIONS

Many individuals and groups in the public and private sectors, together with events, have contributed to the rekindling of national interest in maglev technology development and implementation in the United States. Of course, the actions of the U.S, legislative and executive branches of the federal government determine the nature and extent of such new enterprise's as maglev, because the private sector alone cannot bear the development costs or risks. This is particularly true of large-scale transportation programs where the regulatory environment has yet to be fully defined. No transportation system proposed by the private sector without substantial federal government involvement has been able to proceed in the United States. The analyses completed to date indicate that the public benefits of developing a U.S. maglev system and implementing it domestically will amply justify the development cost to the public. Of course, market forces are likely to play a dominant role in determining which maglev system is ultimately implemented. However, in the opinion of this author, by participating in the international maglev development competition, the nation greatly increases the likelihood of implementing the most cost-effective design, thereby maximizing the public benefits.

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