National Maglev Network

Examining Requirements for Locating a National Maglev Test & Certification Facility in Nevada

The NMTCF is the First Step in Implementing a National Maglev Network, Attracting the Private Investment, and Stimulating the Creation of a Maglev Industry

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READINESS RESOURCE GROUP

INTERSTATE MAGLEV PROJECT

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Examining Requirements for Locating a National Maglev Test & Certification Facility in Nevada

Executive Summary

This paper discusses the potential advantages and benefits of locating a test facility and the nucleus of a new Maglev industry in Southern Nevada. As the industry grows it will draw on the capabilities of California and the Southern Intermountain West.

The facility will test, and certify a new transport system based on the advanced 2nd generation superconducting magnetic levitated (MagLev) technology, invented by American scientists, Drs. James Powell and Gordon Danby. The Interstate Maglev Project (IMP) formed by James Jordan, the inventors of superconducting Maglev, and the Maglev 2000 Corporation are looking for potential sites to locate the facility. The mission of the facility is to generate performance and system cost data to compare with the 1st generation Maglev systems and high-speed steel wheel rail systems.

IMP has proposed that the facility be Government Owned Contractor Operated. The Federal Government would fund construction of the facility and carrying out the testing program. The program will certify Maglev vehicles and the guideway as public carriers. Current vehicle conceptual designs include: a roll-on, roll-off highway freight truck carrier, a passenger carrier, and a passenger and auto carrier. The Test Facility will use the 2nd generation designs for prefabricated guideway sections that include: electronic switches, on grade guideways, elevated guideways, station platform guideways, and Maglev Emplacement on Railroad Installation (MERRI) guideways. After the test program is complete and the vehicles are certified for public use, the Maglev vehicles manufacturing industry will buy back the facility from the government and continue use it as a proving ground for new vehicles.

IMP's goals are to win public support for a National Maglev Network for intercity passenger and freight to link the metropolitan areas of the U.S. and North America, establish the international guideway gage standard that would permit deployment of the Maglev passenger and freight technology in global markets.

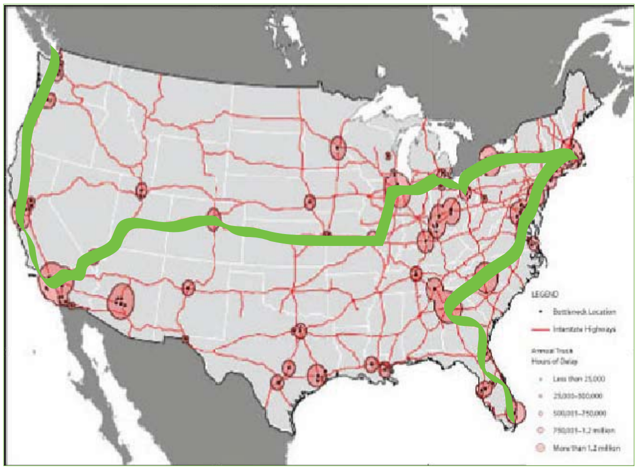
IMP provided conceptual design information about Maglev-2000 and the Maglev Test Facility and requested Mr. Robert Coullahan, President of Readiness Resource Group (RRG), Inc. a Las Vegas based veteran-owned small business, to provide information about sites in the Southern Nevada that would distinguish the site for location of the National Maglev Test and Certification Facility (NMTCF). Las Vegas was thought by IMP to have strong potential because of the long time interest of Senator Harry Reid in Maglev transport, an active community leadership group who were promoting Maglev, the Las Vegas to Anaheim Maglev route authorized in Public Law, the capability of Las Vegas to host visitors who would come to see and ride the 2nd generation superconducting Maglev-2000 system and witness its performance characteristics, and to have high-revenue truck traffic for deliver of food and other supplies for the tourists, convention visitors, and residents of Las Vegas.

As this paper discusses, the site and elements of a NMTCF are envisaged in a uniquely compatible location in the Eldorado Valley of Nevada. The Eldorado Valley presents compelling attributes for alignment of a high-speed test guideway of sufficient length and contour to serve the performance and safety testing vital to validation of the Maglev transport systems that must be tested. The attributes are:

- Access to renewable electric power
- Nearby concrete production facility
- High number of visitors and visitor facilities

- Strong Civic Support for Maglev
- Strong Technical University
- Strong Congressional Maglev Leadership
- A key node in the Golden Spike, the first transcontinental Maglev route

Golden Spike: 1st Phase of Nat'l Maglev Network



- 6150 miles of Maglev-2000 Network completed by May 19, 2019 (150th Anniversary of Transcontinental RR completion at Promontory, Utah)
- E-W Route (San Diego – Las Vegas – Denver-Chicago – Albany – Boston)
- N-S Routes (Seattle-San Diego & Boston – Miami)

Golden Spike project construction is easier than Interstate Highway System, which built 10,000 miles in first 5 years & 20,000 miles in first 10 years

IMP believes that a high-speed, all-weather, all electric national Maglev network is urgently needed to reduce the consumption of oil, and reduce the generation of global warming gasses, improve surface transport productivity by moving passengers and freight at aircraft speeds for very low costs, and relieve congestion on its existing surface and air transport networks.

IMP believes a Maglev passenger and freight transport market will create a new industry for the manufacture of superconducting Maglev vehicles and guideway systems in the U.S. The vehicles manufacturing industry, construction of a new 25,000 mile U.S. intercity passenger and freight transport network, and operation of the services, multi-modal terminals, and passenger stations will create millions of new jobs for construction and operation of the system. The network will complement and supplement an overstressed, oil dependent airline, trucking, railroad and passenger and freight transport network of airports, Interstate and National highways, and railways that have evolved over the history of the U.S. These networks, which link our production and natural resource centers, ocean, river and lake ports with consumers both in the U.S. and the World are vital to the U.S. economy.

Specifically, IMP has proposed that the Department of Transportation fund a National Magnetic Levitation (MagLev) Test and Certification Facility. It is offered as we move to implement the American Recovery and Reinvestment Act of 2009, which includes provision of $8 billion to advance development of high-speed rail and to improve intercity passenger rail service in corridors across the nation.[1]

<u>IMP makes the case that the transition from oil-fueled transport to electric transport is inevitable.</u> Oil is running out and there are no acceptable substitutes. Maglev is all-electric and is extremely energy efficient compared to other modes of transportation including high speed intercity rail. Maglev has been proven to be much faster, much quieter, smoother and more comfortable than the high-speed steel-wheel rail systems deployed in Europe and Japan. The **Exhibit 1** below compares the energy efficiency of different transport modes in barrels of oil equivalent per 10,000 passenger miles.

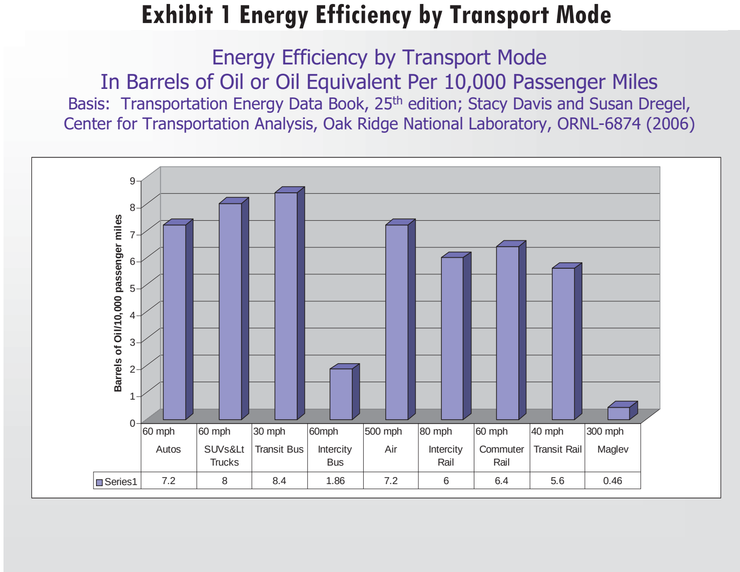
[1] American Recovery and Reinvestment Act of 2009, Conference Agreement, 12 February 2009.

1st generation passenger Maglev systems now operate in Japan, China, and Germany. Japan's system is based on the 1966 superconducting Maglev invention of American scientists James Powell and Gordon Danby. These 1st generation systems are expensive and their revenues are too small for private financing. 2nd generation Maglev systems are projected to cost significantly less per guideway mile than both 1st generation technologies and foreign high-speed rail systems and because they carry high revenue, long distance roll-on, roll-off trucks, as well as passengers, payback time will be less than 5 years, enabling private investment. This value proposition is what must be tested and demonstrated.

The NMTCF is an urgent and compelling need that should be made operational on a fast-track so as to engage and not impede the implementation of maglev systems within the United States, failure to do so will condemn future generations to 20th century solutions and forfeit an opportunity for technology leadership and expansion of our industrial base to foreign markets. Key scientists and engineers believe that the 2nd generation Maglev Emplacement on Railroad Infrastructure (MERRI) system can be demonstrated at a test facility in less than 18 months.[2] 2nd Generation Maglev technologies must be tested and validated for operational use. The data from this test program will be compared with the cost and performance data of the Japanese and German Maglev systems and the European and Japanese high speed steel wheel rail systems.

The implementation of a National Maglev Test & Certification Facility will protect future transportation infrastructure and serve as a resource multiplier for standards-based, high-performance design and engineering proving ground for the future green national transportation network. It is a vital component in the creation and sustainment of the U.S. industrial base; it will provide the essential performance metrics for the enormous investments the American taxpayer in carrying out the fiduciary responsibilities of the American Recovery and Reinvestment Act.

Exhibit 1 Energy Efficiency by Transport Mode



The 2nd generation maglev has been developed by to overcome the cost and revenue shortcomings of the first generation. Components have been built and tested. All that is needed is assembly, testing of the system including an advanced positive vehicle control system. The authors believe U.S. DOT should use the ARRA stimulus package to fund the NMTCF.

[2] Jordan, James, 2008.

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Examining Requirements for Locating a National Maglev Test & Certification Facility in Nevada

"Throughout our history the federal Government has catalyzed good ideas, invested in the ingenuity and entrepreneurship of the American people, and let the private sector flourish… faced with an economic crisis today, we have an opportunity to make similar investments that will help our country prosper in the years to come."

- Senator Harry Reid, S2068, Congressional Record, February 10, 2009

Requirements for a Test & Certification Facility

A National Maglev Test & Certification Facility (NMTCF) would serve to test and certify for passenger and freight carriage the complete systems proposed for operational implementation. Applying the best practices of systems engineering, test and evaluation, the NMTCF would thus address system design for operational feasibility, reliability, maintainability, usability (human factors, ergonomics), supportability (serviceability), producibility and disposability (recycling strategies for all materials used in production), and overall design for affordability (cradle-to-grave life-cycle cost). Initial testing would be executed in at least three (3) phases.

Phase 1 is designed to test the prototype 60 passenger capacity Urban/Suburban Vehicle on a 1.5 Mile Guideway at speeds up to 100 mph, testing on Elevated Monorail, Electronic Switch and RR Track Guideways, and testing Superconducting Magnets.

In Phase 2, both passengers and freight carrier vehicles would be tested up to the maximum speed anticipated for intercity service, i.e., 300 mph on an extended guideway, e.g., 5 miles in length. The Phase 2 guideway would incorporate 3 sections, representing the different types that would be used in the advanced maglev system, i.e.:

- Elevated monorail section
- Elevated planar switch section
- RR track adapted for advanced maglev travel

The Phase 2 passenger vehicles would have a nominal length of 110 feet, with a nominal capacity of 100 passengers. The Phase 2 truck carrying vehicles would be able to carry a fully loaded 80,000 pound 18 wheeler highway truck with roll-on, roll-off capability or several TEU containers.

The performance tests would be for the urban/suburban vehicle, except at higher maximum speed. The performance tests would include:

- Acceleration and deceleration capability
- Air and I^2R drag as a function of speed
- Linear synchronous propulsion motor requirements and efficiency
- Ride quality
- Vehicles response to external inputs, e.g. failure of guideway loop winds, etc.
- Emergency braking capability

In an initial Phase 2 test activity because of the short guideway length, continuous running tests at full speed are not possible. Instead, vehicles would accelerate to full speed from one end of the guideway travel at maximum speed for some distance, and then decelerate and stop at the other end of the guideway. They then would reaccelerate and travel back to their original starting point.

A planar electronic switch would be located in the middle section of the guideway, to test electronic switching at high speed. Operation on the guideway section using adapted RR trackage would be at lower speeds, e.g., at a maximum speed of ~100 mph. (RR trackage operation would primarily be in urban/suburban areas, where the Maglev vehicles would not operate at intercity type speeds. Accordingly, the RR track section of the guideway would be located at one end of the 5-mile long guideway.)

Initial Phase 2 operation would be at speeds less than 300 mph, e.g. starting at 100 mph, the maximum speed tested in Phase 1, and then gradually increasing speed to the design maximum of 300 mph. As in Phase1, while continuous high speed running tests would not be possible, many hundreds of start/run/stop tests would be carried out; providing excellent data on vehicle performance and reliability using both passengers and truck carrying vehicles.

Phase 2 would be divided into 3 sub-phases, Phase 2A, Phase 2B, and Phase 2C. Phase 2A would construct and test the passenger and truck carrier vehicles at speeds up to 100 mph on the already constructed 1.5 mile guideway built in Phase 1. In Phase 2B, to be carried out in parallel with Phase 2A, the 3.5 miles of additional guideway would be constructed and made ready to connect to the existing Phase 1 guideway.

In Phase 2C, the Phase 2B guideway section would be connected to the existing Phase 1 guideway and performance testing of the passenger and truck carrier vehicles carried out at higher speeds, up to the maximum design speed of 300 mph.

Phase 3 would involve continuous high speed running tests for thousands of hours to verify safety and reliability performance so that the MAGLEV-2000 system could be certified for commercial services.

For high speed running tests, Phase 3 will require a much longer guideway than in Phase 2, e.g., with a nominal length of 25 miles instead of the 5-mile length for Phase 2 operation. The Phase 3 guideway would have end loop sections with electronic switching, enabling a single long track instead of a loop configuration, which would require a 2-way track. When the MAGLEV 2000 vehicles reached one end of the long ~ 25 mile guideway, it would travel onto the end loop through the electronic switch section, loop around and then return back to the long section through the electronic switch. The same process would occur at the other end of the long straight section. Some reduction in vehicles speed, e.g. down to 150 mph, would be required in the end loop sections, to minimize their length of guideway.

An attractive option would be to have one end loop constructed using the RR guideway type, with operation at 100 mph, to demonstrate long term running capability on the MAGLEV-2000 RR Guideway.

Depending on the location of the long Phase 3 guideway, it could become a section of a larger commercial route following its use in the Phase 3 portion of the demonstration program. There are a number of such locations in the U.S. that could evolve into commercial routes. Phase 3 test routes could be selected for testing performance in all weather conditions.

The Phase 3 programs would demonstrate the ability of the MAGLEV-2000 system to operate in all weather conditions, e.g. storms, winds, rain, cold and warm temperatures, etc. If located in an ice/snow region, the ability of MAGLEV-2000 to operate on the narrow beam monorail in heavy snow conditions would also be demonstrated.

Exhibit 2 summarizes the principal features and objectives of the 3 Phase demonstration and certification program, together with its projected schedule and cost. These are preliminary estimates that would be developed in much more detail in Phase 1A of the program, which should be funded by the U.S. Department of Transportation (DOT).

Exhibit 2 Principal Features and Objectives of 3 Phase MAGLEV Demonstration and Certification Program

Phase	Principal Features And Objectives	Schedule and Cost
Phase 1	▪ Test of Urban/Suburban Vehicle on 1.5 Mile Guideway ▪ 100 mph Maximum Speed, 60 passenger Capacity ▪ Test on Elevated Monorail, Electronic Switch and RR Track Guideways ▪ Test HTS Superconducting Magnets	▪ 24 Months
Phase 2	▪ Test of High Speed Intercity Passenger & Highway Truck Carrier Vehicles on 5 Mile Guideway ▪ 300 mph Maximum Speed ▪ Test on Elevated Monorail Switch Section, and RR Track Guideways (100 mph Maximum on RR Track) ▪ Start/Accelerate/Decelerate/Stop Tests	▪ 24 Months
Phase 3	▪ Continuous Running Tests of High Speed Intercity Passenger & Highway Truck Carrier Vehicles Plus Urban/Suburban Vehicles on 25 Mile Guideway ▪ 1000's of Hours of Continuous Running Tests ▪ Test on 3 Guideway Types in All Weather Conditions ▪ 25 Guideway May Be Incorporated In Part of Commercial Route	▪ 18 Months

Vision for Implementation

This paper has highlighted emergent, available technologies for 2nd generation maglev systems design and development. As a nation we have benefited from robust research, development test and evaluation (RDT&E) protocols and well-developed, proven systems engineering methodologies to define and implement large-scale systems. We must put these protocols and methodologies to work to guide the significant taxpayer investments now ahead for green transportation systems.

The author unabashedly proposes that a unique opportunity exists for the formation, operation and beneficial use of a National Maglev Test & Certification Facility in the State of Nevada.

Key scientists and engineers believe that the 2nd generation Maglev Emplacement on Rail Road Infrastructure (MERRI) system can be demonstrated at a test and certification facility in less than 18 months. It is believed they can demonstrate that 2nd Generation Maglev is far superior to high speed steel wheel rail systems at less cost and would be capable of carrying freight trucks as well as passengers. Following the MERRI demonstration efforts could be focused on building the elevated guideway and demonstrating the full system at very high speeds. The site and elements of a NMTCF are envisaged in a uniquely compatible site in the Eldorado Valley of Nevada.

Exhibit 3 provides a recent aerial image of the area of interest, which includes the Nevada Solar One (NSO) power generation plant and other features.

Exhibit 3 Eldorado Valley, Nevada

The initial NMTCF Program would serve to:

- Demonstrate and certify maglev system components.
- 3 Phase Demonstration & Testing Program
  - Phase 1: Testing @ 100 mph on 1 Mile Guideway
  - Phase 2: Testing @ 300 mph on 4 Mile Guideway
  - Phase 3: Long Running Testing on 15-25 mile Guideway (optionally exploiting a segment of a Future Commercial Route)
- Tests of:
  - Truck and Passenger Transport Vehicles
  - Elevated & Monorail Guideway Sections
  - Electronic Switching
  - Levitated Travel via Maglev Emplacement on RR Track (i.e., MERRI).
  - Facility Security and Safety Features, Functions and Standards.

It is projected that a five-year NMTCF program would require a budget of ~ $600 M (USD). The cost estimate is preliminary and would be developed in much more detail in Phase 1A of the program, which is proposed to be funded by a grant from the DOT.

Where and Why?

Site selection is of course a volatile process however there is **an urgent and compelling need** to implement this test program to enable, validate, and support aggressive schedules of development for transportation infrastructure. To this end, rational evaluation of fundamental site characteristics suggests there is a unique solution available in the Eldorado valley of southern Nevada.

The Eldorado Valley is southwest of Boulder City, Nevada. U.S. Highway 95 to Searchlight, Nevada, transects the valley in a north-south direction. Geographically, Eldorado Valley extends from Boulder City to Searchlight. The region of influence includes areas south of Boulder City adjacent to U.S. Highway 95 near the junction with State Route 60.

Elevations range from about 2,152 m (7,060 ft) on the west at McCullough Mountain to 521 m (1,708 ft) at the playa in the north-central part of the valley. On the east, the Eldorado Mountains rise to elevations only slightly above 1,524 m (5,000 ft).

The U.S. Bureau of Land Management patented 107,412 acres of Eldorado Valley to the state of Nevada, at which time this land was transferred to the city of Boulder City. Boulder City has designated 6,000 acres of this land for a Solar Enterprise Zone facility. This zone is excluded from a conservation easement within these transferred lands that is managed for the conservation, protection, restoration, and enhancement of the desert tortoise and its habitat. The US Department of Energy is authorized to enter into a partnership agreement with the solar industry, with Nevada stakeholders, and with university systems to develop facilities.

Two existing 500-kV substations and a third substation under construction are within a few miles of the proposed Solar Enterprise Zone facility in Eldorado Valley: Southern California Edison's Eldorado Substation, Los Angeles Department of Water and Power's McCullough Substation, and the Marketplace Switching Station. When the Marketplace Switching Station is completed, these substations will connect the transmission systems of California, southern Nevada, and Arizona.

Two major Southwest Gas natural gas pipelines transect Eldorado Valley. One pipeline is immediately adjacent to U.S. Highway 95, and the other pipeline is approximately 2 km (1 mi) west of the highway. Depending on where the proposed Solar Enterprise Zone facility is sited, the pipe lines could be immediately adjacent or up to 10 km (6 mi) away. Both pipelines are main supply lines for the Las Vegas area and consequently are insufficient to support the Solar Enterprise Zone facility during winter months. An additional 51-cm (20 in) pipe line from an existing main line would be necessary; the nearest main gas pipe line is an El Paso Gas pipe line south of Laughlin, Nevada, 110 km (68 mi) away.

The nearest rail line to the Eldorado Valley site is the Union Pacific line in Boulder City, which connects Boulder City with Las Vegas. No rail spur exists on a Solar Enterprise Zone facility site. The nearest airfield is in Boulder City. Law enforcement is provided by the Clark County Sheriff's Department. Fire protection for Eldorado Valley is provided by the U.S. Bureau of Land Management.

The landscape character of Eldorado Valley is typical of the Great Basin. Regional topography consists of mountain ranges arranged in a north-south orientation, separated by broad valleys. The existing viewscape includes two Bureau of Land Management Wilderness Study Areas located in the McCullough Range and one in the Eldorado Mountains, U.S. Highway 95, portions of Boulder City, power transmission lines, gravel quarries, and electrical substations.   **Exhibit 4** provides a topical view of key features in the Eldorado Valley.

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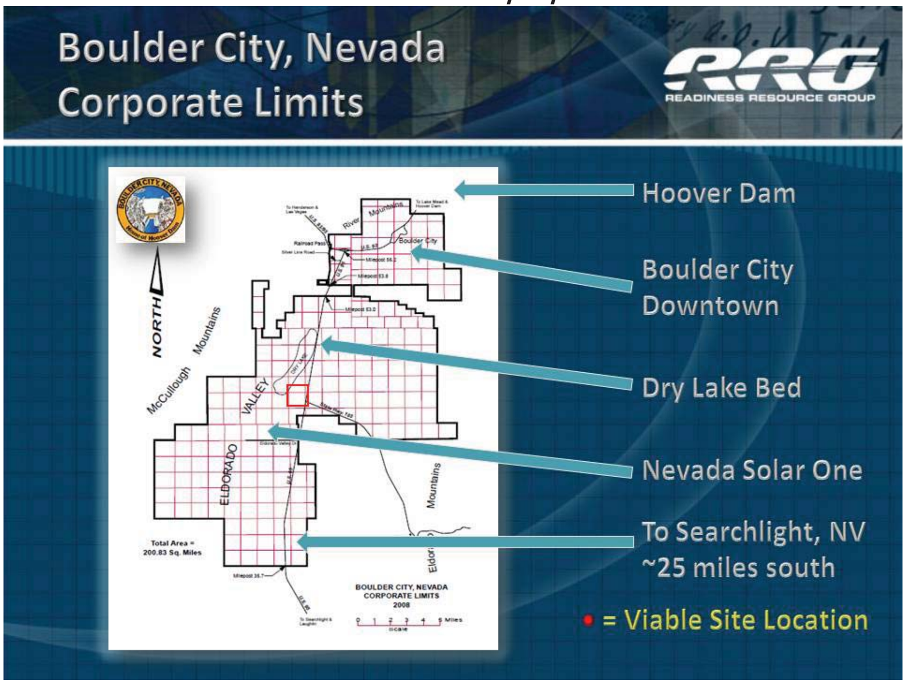
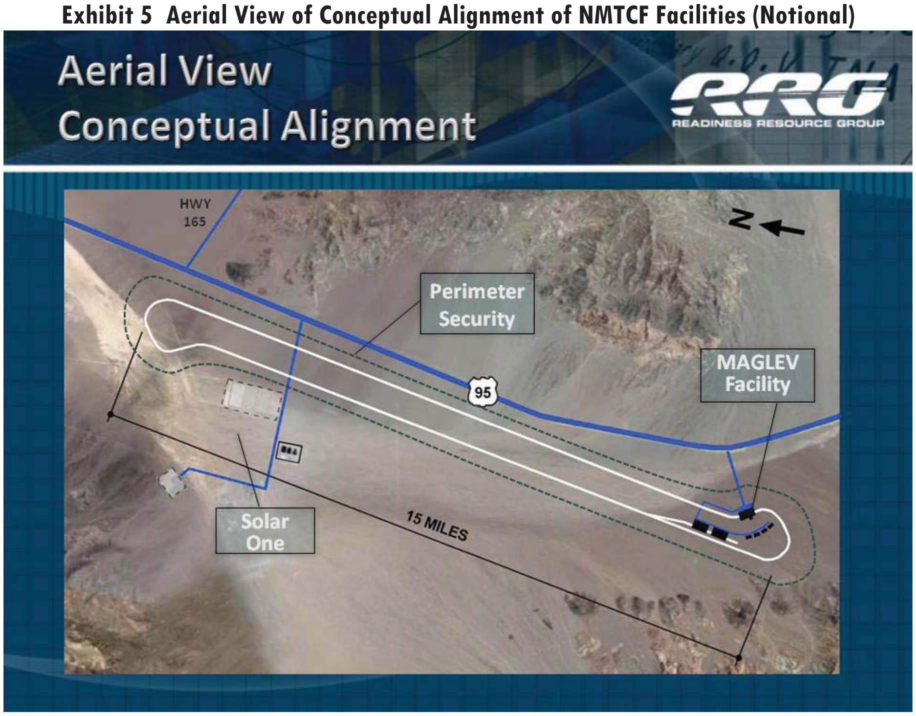
Exhibit 4. Eldorado Valley Key Features



The Eldorado Valley presents persuasive attributes for alignment of a high-speed test guideway of sufficient length and contour to serve the performance and safety testing vital to validation of technologies that must be tested. **Exhibit 5** provides a notional alignment of NMTCF facilities and guideway that would be feasible for rapid implementation.

Exhibit 5 Aerial View of Conceptual Alignment of NMTCF Facilities (Notional)



Why Boulder City?

- Over 200 square miles of incorporated area under singular city control.
- Single point of coordination for fast-track permitting and long-term land leases or easements.
- Boulder City can provide electric power at cost from Hoover Dam.
- Dry lake bed in Eldorado Valley offers natural features compatible with large oval track essential to a comprehensive R&D test facility.
- Long-haul electrical transmission lines transit this area linking Hoover Dam to Las Vegas: inexpensive access to the power grid.
- Site adjoins a cement production facility and quarry – beneficial for cost-effective guideway production and evaluation.
- Prospective area is adjacent to the *Nevada Solar One* site, of interest for "maglev energy storage" research in the Boulder City "Energy Corridor".
- Location is within 30 miles of downtown Las Vegas and on U.S. Highway 95 south to Searchlight, Nevada.

Boulder City was the product of government action to help America rise up from the Great Depression with the bold and big engineering endeavor that created the Hoover Dam. Now we face another economic chasm and this model city and its unique natural features can provide the springboard for one more big and bold engineering endeavor – launching the Nation's green transportation future and helping solve the vexing problem of renewable energy storage.

Exhibit 6 provides a conceptual view of the NMTCF emphasizing the engineering and assembly facilities and a control and visitor station that would include a public access and educational component to enhance understanding of maglev technologies, proposed systems and, perhaps, the strategic vision of the national interstate maglev project.

Exhibit 6 NMTCF Conceptual View

Expected Outcomes

The implementation of a National Maglev Test & Certification Facility will protect future transportation infrastructure and serve as a resource multiplier for standards-based, high-performance design and engineering of our green transportation network. It is a vital component in the creation and sustainment of our industrial base; it will provide the essential performance metrics for the enormous investments the American taxpayer will now make in carrying out fiduciary responsibilities of the Economic Stimulus Bill.

Actions Ahead

The author respectfully recommends that decision-makers in position to impact the implementation of next generation high-speed transportation systems comprehensively evaluate the importance of a robust test and certification program to guide the performance, safety, security and success of our 21st century transportation infrastructure.

The reader is urged to visit the following URL link to view a four-minute video on the work of Drs. Powell and Danby:

http://www.readinessresource.net/maglev/2000.html

Acknowledgments

The author recognizes the pioneering work, innovations, and publications of Dr. James Powell, Dr. Gordon Danby, and Mr. James C. Jordan, whose contribution on the future of maglev transportation have made this concept paper possible. These are patriots of enormous vision, ingenuity and action who continue to serve our nation with problem-solving skills that offer America opportunities for 21st Century technology leadership and economic security.

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Appendix A

Justification for Funding a National Maglev Test & Certification Facility Out of the Funds Provided for High Speed Rail

"In underfunding U.S. maglev technology, we have created a gap in the market that has been filled by the German Transrapid *design, which has been established as an unofficial standard in the industry. As this technology has become more prevalent, we have crowded out recent advances by U.S. scientists who have moved maglev technology forward and beyond that of competing groups overseas."*

- Congressman Tim Bishop in a Letter to Rep. James L. Oberstar, Ranking Member Committee on Transportation & Infrastructure, July 14, 2004

Overview

This information was provided to Robert J. Coullahan, to establish the requirements for establishing a National Maglev Testing & Certification Facility (NMTCF) in the Southern Nevada region near Las Vegas. The NMTCF would be the first step in deploying a new transport system based on the advanced 2nd generation superconducting magnetic levitated (MagLev) transport, invented by American scientists, Dr. James Powell and Gordon Danby, the first since the airplane. A high-speed, all-weather, all electric national Maglev network will improve surface transport productivity, reduce the consumption of oil, and reduce the generation of global warming gasses.

Manufacturing superconducting Maglev vehicles and guideway systems will create new industries for the U.S. and millions of new jobs for construction of a new 25,000 mile U.S. intercity passenger and freight transport network to complement and supplement an overstressed, intercity, oil dependent airline, trucking, railroad and passenger and freight transport network of airports, Interstate and National highways, and railways that have evolved to link our production and natural resource centers, ocean, river and lake ports with consumers both in the U.S. and the World.

Adaptation of innovative transportation technologies has been fundamental to the economic success of the United States. From paddle and pole rafts, to barges, to sail, to steamships, to horse and wagon, to steam locomotives to internal combustion engines for trains, trucks, autos, planes, and containerized cargo has steadily lowered the cost of and improved the energy efficiency of moving goods and people. U.S. leadership in transport technologies has contributed enormously to the productivity of our economy, our standard of living, and our ascendancy to the largest economy in the World. Government investments like Lincoln's Transcontinental Railroad, Teddy Roosevelt's Panama Canal, Eisenhower's Interstate Highway System, and Kennedy's Apollo Project, the National Maglev Network would transform America's future. All of these major innovations involved great risk and strong government support.

Steadily increasing numbers of unemployed, business failures, home foreclosures and the collapse of credit in the United States has created an economic crisis that has only been exceeded by the Great Depression. The United States government led by the newly elected President Obama has acted with the new Democratic Majority Congress to address this growing crisis by providing a government infusion of cash by taking equity in the Nation's private banks and investment banking houses, and providing further economic assistance by enacting the American Recovery and Reinvestment Act of 2009 which was signed into law in Denver on February 17. Of the $787 Billion "Stimulus Package", $111 Billion is directed to infrastructure and science. Most of the infrastructure money goes for repair of bridges, tunnels, and highways but there is 8 Billion dedicated to the development of High Speed Rail Corridors as defined in the Amtrak reauthorization bill passed last year and further study of two demonstration Maglev routes – a route from Las Vegas, NV to Anaheim, CA and another route to be selected East of the Mississippi - that were designated in the Technical Corrections Act to SAFETEA-LU. The Interstate Maglev Project proposes to amend the policy direction to supplement the current Maglev Route Environmental Statement study effort on a route that links Las Vegas to Anaheim and the sites under consideration East of the Mississippi – Pittsburgh to the Airport, Chattanooga to Atlanta, and Baltimore to Washington, by establishing National Magnetic Levitation (MagLev) Test and Certification Facility to carry out a Maglev Transportation Technical Testing Program.

Proposed Amendment to Establish a Maglev Transportation Technical Testing Program

> **Implement, to the maximum extent practical, preliminary qualifications of maglev guideway gage standard, including lowest cost potential for two-way elevated narrow-beam superconducting repulsive guideway system with capabilities for carrying tractor-trailer type highway freight trucks and freight containers, high speed electronic switching, dual-use of conventional railway trackage and deployable along the rights-of-way of highways, railways, and power lines consistent with section 302 of Title 49, United States Code; provided that the Secretary of Transportation in collaboration with Department of Commerce, National Institute of Standards and Technology shall establish a six-year engineering development, demonstration and technical testing program to competitively test preliminary maglev guideway gage standards and establish these standards by rules issued not later than 7 years from the date of enactment of this paragraph.'**

Maglev will soon be a major mode of transport in the United States. It is urgent to establish a competitive program to select the Maglev system and its associated guideway gage standard that best meets practical and useful national goals. Today, instead of seeking the best Maglev system for America, we are relying on ad hoc decisions made for specific projects that do not take into account national needs and the potential for the development of advanced Maglev systems that will be much lower in cost, and that will have much greater capabilities. These un-coordinated federally funded projects are not directed at what is best in cost and how they can contribute to future national transportation needs.

The U.S. Maglev transport system should be an integrated national network capable of transporting military and FEMA emergency response supplies, commercial freight, and passenger traffic. Built along existing rights-of-way, it would be (1) high-speed; (2) safe; (3) capable of carrying heavy freight loads; and (4) powered by electricity from domestic fuel resources and generating sites. Unlike our passenger

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rail systems, which require federal subsidies, revenues from intercity truck type freight would substantially contribute to Maglev operating and construction capital costs.

The proposed amendment to the Maglev Demonstration Program sets some practical objectives for Maglev transport projects, and mandates a competitive demonstration and testing program that will lead to effective Maglev transportation in the U.S. It requires that government investment be directed towards developing the lowest cost, safest and most reliable advanced 2nd generation superconducting maglev transport system that would permit: carrying tractor-trailer freight trucks and containers as well as passengers; employs high-speed electronic switching to off-line stations; is inherently stable and has large clearances between the high-speed vehicles and the guideway they travel on and can also travel on dual-use conventional railroad trackage where appropriate. The goal is to develop a small-footprint elevated narrow beam superconducting repulsive guideway for an all-weather national network that can be built along the rights-of-way of highways, railways, and power lines consistent with the policies already established in Section 302 of Title 49, United States Code (relating to policy standards for transportation).

The all-electric Maglev transport system could be one of the most effective ways for the United States to reduce its dependence on imported oil, improve its position in international trade, and reduce the negative impact of transportation on our health and the environment including the emission of global warming gasses.

Maglev investments should be directed towards systems that can handle freight as well as passengers at high speeds. Transporting both truck-type freight and passengers on the same Maglev system makes good economic sense, good highway safety sense and is one of the primary objectives of this amendment. The more powerful magnets of the 2nd generation maglev system invented by Drs. James Powell and Gordon Danby permit carrying intercity trucks as well as passengers. The U.S. advanced 2nd generation Maglev system can be built for 15 to 20 million dollars per mile, compared to 40 to 50 million per mile for the 1st generation foreign Maglev systems, and is also very cost competitive with high-speed steel-wheel-on-steel rail systems like the high-speed Acela, TGV, or the Bullet Train.

U.S. annual outlays for intercity trucks exceed 300 Billion dollars, compared to only 60 Billion for air passengers. Carrying 3000 intercity trucks daily on a Maglev route, one fifth of the trucks on a typical Interstate highway, yields revenue equivalent to 150,000 passengers. A 2nd Generation Maglev route would be paid back in 5 years. With this earnings potential, the system could be financed with private investment and would not require a government subsidy.

Having electronic switching permits more flexible station spacing for passenger convenience, freight accessibility and higher mainline speeds. The 2nd generation Maglev also has the unique capability to electronically switch at high speeds from the main guideway the desired off-line station for loading and unloading, something not possible with the German and Japanese 1st generation Maglev systems, and allows the 2nd generation Maglev to have many stations in a metropolitan area without sacrificing speed and frequency of service.

Having large clearance narrow-beam guideways enables the inherently strongly stable superconducting Maglev system to use the latest vehicle improvements that maximize safety and permit operation under all weather conditions. Having a small footprint, the elevated system following along existing rights-of-way will minimize grade crossing accidents, environmental impacts and disruptions to infrastructure and people.

Advanced 2nd generation Maglev has the unique capability to operate on conventional railroad tracks as well as elevated guideways so that when entering built up metropolitan areas it can use existing trackage to service the area, without having to remove or modify the surrounding buildings and other infrastructure. Conventional trains can still continue to use the same trackage, if desired. This feature would allow the nearly seamless integration of existing light rail, and public transit systems.

Finally, having a system deployable along the national highway system and other rights of way is consistent with policies already established in law. The standardization of the guideway system would lead to a faster deployment of a high-speed network, which in addition to its use for normal transport, can serve as a critically needed transportation resource for national emergencies, fast-evacuation from life threatened areas and emergency supply to areas that have experienced disasters.

Oil production in the United States has been declining for a number of years, as a result, the increasing population and the growing U.S. economy is becoming more dependent on imported oil. In the future, the transportation that supports the dispersed economic centers of the United States will by necessity have to switch, in large part, to electrically powered systems. Electrical generators can draw energy from a much broader variety of raw resources: coal, uranium, solar, geothermal, hydro, and wind energy. The U.S. really has no choice but to conserve and stretch precious global oil supplies. Replacing oil consumption with electricity in the transportation sector is vital to assure our continued national economic and military security.

A steady march toward electrifying our present oil consuming surface transportation system makes good long-term economic sense.

The mission need and desirable capabilities of a U.S.-based National Magnetic Levitation Test and Certification Facility (NMTCF) that would serve to test, certify, and validate technologies, systems, procedures, and concepts of operation for advanced maglev systems.

This paper was developed to advance awareness of extant 2nd generation maglev technologies and the vital need to implement a U.S.-based test and certification program that will evaluate, validate, and certify emerging maglev technologies for operational implementation into the public service. It is critical to acknowledge that while this paper focuses on the opportunities presented by advanced 2nd generation maglev technologies, the need for a U.S.-based test facility transcends these technologies and is equally an unmet need for comparison with extant 1st generation maglev and high speed rail transport systems currently manufactured by foreign sources.

The NMTCF is an urgent and compelling need that should be made operational on a fast-track so as to engage and not impede the implementation of maglev systems within the United States, failure to do so will condemn future generations to 20th century solutions and forfeit an opportunity for technology leadership and expansion of our industrial base to export U.S. manufactured systems to global markets.

Background

During his recent Town Hall meeting in Fort Myers, President Obama praised the High Speed Rail line in Shanghai, China (actually a Maglev line) and said that it “Shamed American railroads”. Other leaders, including Mayor Michael Bloomberg of New York, have cited the Shanghai Maglev line as an example of America’s failure to innovate.

This perspective is indeed ironic. Over forty years ago in 1966, American scientists, Gordon Danby and Jim Powell invented Superconducting Maglev, the first new mode of transport since the airplane. Maglev vehicles are magnetically levitated above and propelled along a guideway at speeds of hundreds of mph, without mechanical contract and engines. Maglev is very energy efficient, does not burn oil, emits no greenhouse gases or pollutants, and is quiet and comfortable.

Danby and Powell's Maglev papers and patent sparked world-wide interest, particularly in Japan and Germany, countries that are now operating commercially ready 1st generation Maglev passenger systems. Japan's system, which is based on Danby and Powell's 1966 inventions, has carried many thousands of passengers at speeds up to 361 mph, the World Record. Japan plans a 300 mile Maglev route between Tokyo and Osaka, to carry 100, 000 passengers daily with a trip time of 1 hour.[3]

Germany's Transrapid Maglev system, which uses conventional electromagnets rather than the much more powerful super-conducting magnets in Japan's system, is now operating in Shanghai. Superconducting Maglev has important advantages compared to electromagnetic Maglev including much larger clearance between vehicles and the guideway, an inherently strongly stable suspension, no need to rapidly servo control magnet current, and the capability to transport very heavy loads.

In contrast to Japan and Germany, America has done very little to develop Maglev transport. Small programs started following Powell and Danby's work in the 1960's, but quickly died when DOT abolished the Office of High Speed Ground Transport. In 1990 Senator Daniel Patrick Moynihan's legislation for a 750 million dollar program to develop a U.S. Maglev System (Danby and Powell served as co-chairmen of Senator Moynihan's Maglev Task Force) passed the Senate, but was killed in the House by vested transport interests. Had it become law, America would today have achieved Senator Moynihan's vision – a National Maglev Network built on the rights-of-way of the Interstate Highway System that interconnect America's cities with 300 mph Maglev.

Danby and Powell have not stopped working on Maglev. The 1st generation Japanese and German Systems, while technically successful, are very expensive, and because they only carry passengers, very limited in revenues. Like High Speed Rail Systems, they require major government subsidy for construction and operation. To overcome these problems and make Maglev attractive for private investment, these remarkable American scientists have developed the new 2nd generation Maglev-2000 systems. Its innovations include a much lower guideway construction cost, and the capability to transport highway trucks, freight, and personal autos as well as passengers at lower cost than flying or driving.

Transporting just 20% of the 15,000 highway trucks per day in a typical Interstate highway would pay back the cost of a Maglev route in less than 5 years, enabling it to be privately financed. A third innovation is the ability of Maglev-2000 vehicles to travel levitated along existing RR tracks whose cross-ties have been filled with very low cost aluminum loops. This allows Maglev vehicles to serve urban and suburban areas without having to build expensive and disruptive infrastructure.

With very modest funding, about 1/1000th of the Japanese and German Maglev expenditures, Danby and Powell have fabricated and successfully tested the Maglev-2000 components – superconducting magnets, guideway beam and loops, and vehicle body. The next step is to assemble and test operating vehicles on a guideway at a government funded Maglev Test Facility. Once certified, private financing could build the 25,000-mile National Maglev Network, enabling high-speed travel anywhere in America.

Like Lincoln's Transcontinental Railroad, Teddy Roosevelt's Panama Canal, Eisenhower's Interstate Highway System, and Kennedy's Apollo Project, the National Maglev Network would transform and brighten America's future, making it once again the World Leader in transport. All of these "bold endeavors" involved major innovations and great risk.

Over the past several years, Maglev advocates have talked with many in government and industry absolutely convinced that the National Maglev Network would benefit America; however there has been

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3 Jordan and Powell, Superconducting Maglev: The Benefits for America, November 2008.

no real action. Policy makers are reluctant to take any risk on new technology. Instead they prefer to purchase existing foreign High Speed Rail (HSR) and 1st generation Maglev Systems, because they are "proven". Various regions in the U.S. are competing for government funds to buy such proven systems, even though they will have to be heavily subsidized by the government, do not create new U.S. industries and jobs, and do very little for America's long-term transport needs.

As Danby and Powell have stated: "real innovation involves taking risks and opposing vested interests. Sticking to 'proven' technology is not innovation. Exhortations that Americans must innovate will remain just empty words."

Understanding the Problem

We need new non-oil technologies that are affordable, efficient, environmentally acceptable, and interconnect all of the U.S., like today's highways, airways, and railways. The only feasible solution is electric transport – electric autos for local trips of 50 miles or so and high speed Maglev for longer distances. Electrically powered Maglev vehicles are magnetically levitated and propelled above a guideway at 300 mph or more. New advanced 2nd generation Maglev-2000 system now being developed will transport passengers, roll-on, roll-off highway trucks, freight containers, and personal autos with only 1/10th as much energy per passenger mile as a 60 mph, 20 mpg auto.

Electric cars and Maglev high-speed guided surface transport, acting together, are the sustainable way to meet U.S. and World transport needs as oil supplies dwindle. 1st generation systems are already operating for both, and improved, higher performance 2nd generation systems will soon be ready for large scale implementation.

For longer passenger trips, and the hauling of truck type freight, the 2nd generation superconducting Maglev, appears ideal. Maglev vehicles are magnetically levitated and propelled along guideways with no mechanical contact or friction, their speed limited only by air drag. They are very energy efficient – a passenger traveling by 300 mph Maglev uses only 1/10th as much energy per passenger mile as a person in a 20 mpg, 60 mph auto.

The message for this crucial time in America's history is clear:

- Oil fueled autos, trucks, airplanes and trains dominated 20th Century transport
- Electrically powered autos and Maglev will dominate 21st Century transport

The transition from oil fueled transport to electric transport is inevitable. Oil is running out and there are no acceptable substitutes.

1st generation passenger Maglev systems now operate in Japan, China, and Germany. Japan's system, based on American scientists James Powell and Gordon Danby's 1966 invention of superconducting Maglev, has carried over 50,000 passengers at up to 361 mph. A 300-mile Maglev route between Tokyo and Osaka to carry 100,000 passengers daily is planned. The German Transrapid System, now operating in Shanghai, is proposed for a route from Las Vegas to Anaheim, California.

These 1st generation systems are expensive, over 60 million dollars per mile, and their revenues are too small for private financing. 2nd generation Maglev systems are projected to cost only 25 million dollars per mile. By carrying high revenue, long distance roll-on, roll-off trucks, as well as passengers, it's payback time will be less than 5 years, enabling private investment.

To meet the oil, environment and economic crises, it has been proposed that the U.S. Government authorize The National Maglev Network to interconnect U.S. metropolitan areas and fund a U.S. Maglev Test Facility to demonstrate its unique and highly capable 2nd generation superconducting Maglev transport systems for passengers and freight.

The Network's first phase as proposed by the Interstate Maglev Project, the 6000 mile Golden Spike Project, would connect the East and West Coasts by a 300 mph Transcontinental route from Boston, via Chicago, Denver, Las Vegas, to San Diego with connections to N-S routes along the Coasts. Golden Spike would operate by May 2019, the 150th Anniversary of President Lincoln's Transcontinental Railroad. The full 25,000 mile Network would be completed by 2030 A.D., but the importance of maglev technology doesn't end there.

Indeed there are other environmental and energy benefits of superconducting Maglev technology.

- Maglev can also benefit America by its ability to store large amounts of electric energy and to transport large amounts of water over long distances.

- Wind and solar power have great potential to sustain global energy needs, but their variable outputs must be matched to grid demand. Maglev, however, can store electric energy at low cost (2 cents per KWH) and very high efficiency. To store electric energy, Maglev would transport heavy concrete blocks from a lower to higher elevation. Returning the blocks to the lower elevation converts their potential energy back to electrical energy for the grid.

- Another application of Maglev technology is the Maglev Water Train which can transport billions of gallons daily, over long distances at low cost. The Water Train could deliver water from the mouth of the Columbia River or other closer sources to the Southwest for less than 1 dollar per 1000 gallons, relieving the region's growing water shortage.

Some observers of the economy believe a program to build HSR routes in the U.S. based on European steel-wheel train technology would be an economic disaster. Such a system would require massive government subsidies, and moreover would not significantly contribute to the goals of efficiently meeting future U.S. transport needs, of reducing U.S. dependency on oil imports, of cutting greenhouse gas emissions and of producing sustainable high tech jobs based on American manufacturing and ingenuity.

In contrast, the 2nd generation Maglev-2000 transport system can be privately financed and will not require government subsidies, unlike HSR, which would be limited to a few isolated high traffic density routes servicing a small number of travelers. HSR trains can only carry passengers. 2nd Generation Maglev vehicles can carry passengers, or roll-on, roll-off, highway trucks, personal autos, and freight containers. Not only does this greatly increase the revenues on a Maglev route, enabling Maglev routes to be privately financed, but it also results in the advanced maglev systems providing a much greater role in meeting U.S. future transport needs than possible with a few isolated HSR routes.

Key reasons why 2nd generation Maglev-2000 is a better transport system than HSR are delineated in **Appendix D – Supplemental Information**.

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Available Technologies

The evolution of maglev technology development is summarized in **Exhibit A-1**. From early technical papers in 1966 to patented technologies in 1968, Jim Powell and Gordon Danby have been pathfinders in the design, development and testing of maglev technologies. Their constant and consistent efforts in advancing the science and engineering toward solutions is only burdened by the inconsistency and indifference of the U.S. Government in sponsoring and sustaining research in this domain, now an important option in the greening of transportation. As Exhibit A-1 suggests, <u>the future is ours to meet with either old inaction or bold new action</u>.

Exhibit A-1 The Evolution of Superconducting Maglev: Choices Ahead (Source: Powell, December 2008)

1960-1970	▪ Danby & Powell Invent Superconducting (SC) Maglev ▪ Japan & Germany Start Substantial Maglev Programs ▪ U.S. Starts Small Maglev Programs (MIT Magneplane, Ford, SRI)
1970-1980	▪ U.S. Cancels Maglev Programs ▪ Japan and Germany Continue Programs, Japan-SC Maglev, Germany-EM Maglev
1980-1990	▪ Sen. Moynihan's $750 million U.S. Maglev program passes Senate, Killed in House. ▪ Japan & Germany Test Maglev Prototypes
1990-2000	▪ U.S. Carries Out Maglev Route Studies ▪ Maglev-2000 Fabricates & Tests Components for 2nd Generation SC Maglev ▪ Japan Tests SC Maglev at Yamanashi; Germany Tests EM Maglev at Emsland.
2000-2008	▪ U.S. Continues Maglev Route Studies ▪ Maglev-2000 Completed Component Fabrication and Testing Program ▪ Japan continues Yamanashi Tests; Germany Builds Transrapid System in Shanghai
2009-2019 Future	▪ Complete Golden Spike Transcontinental Maglev System in 2019 (150th Anniversary of Transcontinental Railroad)
2020-2030 Future	▪ 25,000 Mile National Maglev Network Completed ▪ Japan Completes 300 mile Tokyo to Osaka Maglev System

Powell and Danby embarked on a path guided by very clear operational and performance objectives as noted in **Exhibit A-2**.

Exhibit A-2 Objectives of the Maglev 2000 System (From Powell & Danby)

Maglev-2000 Objective	Maglev-2000 Approach
▪ Reduce Cost of Guideway – 1st generation Systems Too Expensive	▪ Mass produce prefabricated Guideways– Truck to Site, Erect with Cranes/Pre-Poured Concrete Footings.
▪ Enable Levitated Operation on Existing RR Tracks in Urban/Suburban Regions	▪ Very Low Cost Aluminum Loop Panels Attached to RR Cross-Ties – Conventional Trains can Use.
▪ Electronically Switch at High Speed to Off-Line Stations Where Stops Are Scheduled, to Allow Many Stations While Maintaining high Average Speed	▪ Transition from Monorail to Planar Guideway for Switching. Electronic Control of Guideway Loops Allows Vehicles to Either Proceed On Main Guideway or Switch to Off-line Station.
▪ Carry high revenue Highway Trucks and Freight to Enable Private Financing of System	▪ Multiple Superconducting Magnets along Vehicle Body to Enable Heavy Life Capability.
▪ Passengers only Experience Earth Ambient Magnetic Field Strength	▪ Absolutely Necessary in U.S. – use Low Fringe Field Quadrupole Superconducting Magnets.

The reader is referred to the body of work published by Powell and Danby including recent comprehensive briefings at the Maglev 2008 Conference in December 2008. **Exhibit A-3** illustrates the key capabilities enabled by the Maglev-2000 design.

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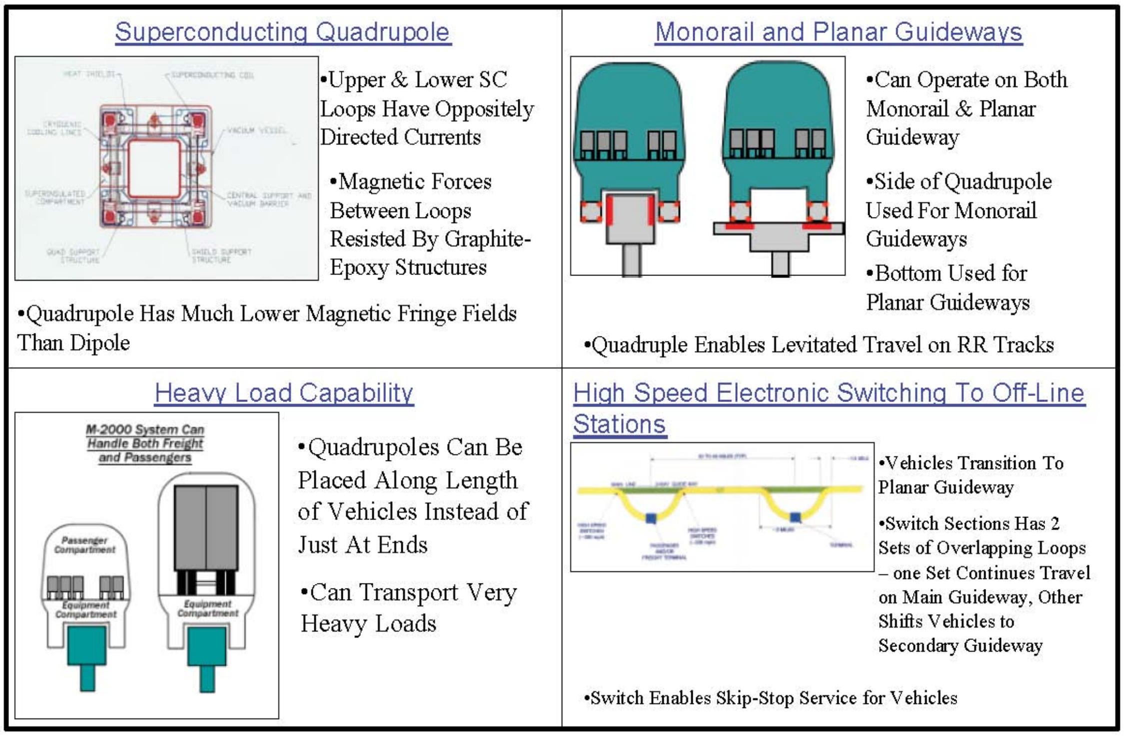
Exhibit A-3 Capabilities Enabled by the Maglev 2000 Superconducting Quadrupole (From: Powell & Danby)



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Appendix B Acronyms

CBCP	Certified Business Continuity Professional
CEM	Certified Emergency Manager
CHS V	Certified in Homeland Security (Level V)
CI/KR	critical infrastructure/key resources
CPP	Certified Protection Professional
DHS	US Department of Homeland Security
DOT	Department of Transportation
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HSR	High-Speed Rail
ISO	International Standards Organization
KWH	Kilowatt Hours
MagLev	magnetic levitation
MERRI	Maglev Emplacement on RailRoad Infrastructure
NIPP	National Infrastructure Protection Plan
NMTCF	National Maglev Test & Certification Facility
RR	RailRoad
SC	superconducting
TEU	Twenty-foot Equivalent Unit, an ISO cargo container standard

Appendix C References

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Appendix D Supplemental Information

Key reasons why 2nd generation Maglev-2000 is a better transport system than HSR are delineated below (Source: Jordan, James and James Powell, 9 Reasons Why 2nd Generation Maglev-2000 is Much Better Than High Speed Rail for Meeting U.S. Transport Needs, Falls Church, VA, December 21, 2008):

1. HSR routes cannot be privately financed and will require massive government subsidies, 1st Generation Maglev will require massive government subsidies. 2nd Generation Maglev-2000 routes can be privately financed.

   The proposed New York to Washington, DC HSR route to replace Amtrak's Acela is projected to cost approximately 40 Billion dollars. The present ridership on Acela is 3.6 million passengers annually or about 10,000 passengers daily.

   10,000 passengers per day is typical of most HSR routes in Europe. The highest HSR ridership in Europe is 20,000 passengers per day on the EuroStar route between London and Paris, through the Chunnel at 50 cents per passenger mile, the typical fare for European HSR, and about what Acela passengers now pay. (The EuroStar carries about 70% of the London to Paris travel, and will not grow very much in coming years.)

   The revenue from 10,000 passengers per day would be about 400 million dollars annually for the 220 mile NYC-Washington HSR route. Assuming that 2/3 of the revenues go towards operating expenses, leaving 1/3 for profit (which is optimistic) it would take 300 years to pay back the proposed HSR route construction cost.

   Private investment would never undertake such a project. Even if traffic doubled to 20,000 passengers daily, equal to the London to Paris EuroStar, it still would take 150 years to pay back construction cost. It would require 300,000 passengers daily to pay back HSR construction costs in 10 years, the maximum payback time that private investment would tolerate. Such traffic densities are completely impossible for any potential HSR route in America.

   Conclusion? HSR routes in America will have to be financed by the government and heavily subsidized. Clearly this is not politically feasible.

   The situation is very different for Maglev-2000 routes. Because Maglev can transport high revenue roll-on, roll-off highway trucks, it can payback its guideway construction cost in under 5 years by carrying just 1/5th of the 15,000 highway trucks that travel daily on a typical Interstate.

   The transport outlay for intercity highway trucks in the U.S. is very large, over 300 Billion dollars annually, with a cost of 30 cents per ton-mile and average haul distances of 500 miles.

   With net revenue of 17 cents per ton-mile and 3000 trucks daily (each with a typical 30 ton load) the 25 million dollar per mile construction cost of a Maglev route could be paid back in only 4 and one-half years.

   In practice the payback time will be even shorter, since most trucking companies will want to use Maglev (one truck going by Maglev can deliver 4 times as much load per week as by highway) and there will be additional revenue from transporting passengers and personal autos. The short payback time will attract private investment.

2. HSR Travel will be much more expensive than Maglev travel. Representative U.S. passenger transport costs are given below in **Exhibit D-1**.

Exhibit D-1 Cost of Passenger Transport in the U.S. vs. Transport Mode

Mode	Cost/Passenger Mile (PM), Cents	Basis
Air Travel	12.7	U.S. Statistical Abstracts (2006 value)
Auto Travel	52 (per vehicle mile)	Datapedia of the United States (2005 value)
HSR Travel	50 Fare	Assumed same as Europe
	125 Gov't Subsidy for Construction	Based on 5% Interest Charges on $40 Billion HSR route Carrying 20,000 passengers per day
	175 Total True Cost	Carrying 20,000 passengers per day
Maglev	10	Net Revenue = 7 cents/PM after deducting operating costs

U.S. data shows that for trips up to ~1000 miles in length, more people drive than take airplanes. For longer trips they tend to go by air. With HSR fares per passenger mile 4 times greater than for air travel, it is very unlikely that people will decide to take HSR in preference to cars, until travel distances are even greater than 1000 miles. It is also unlikely that travelers will choose HSR over air travel because of the higher cost per passenger mile for HSR.

The 125 cents per passenger mile government subsidy assumes that the government sells bonds with a 5% return to pay for construction cost (the recent drop in interest rates for government bonds is only temporary), and that the HSR (route ridership is 20,000 passengers daily on the NYC-Washington DC route.

The Maglev-2000 fare cost has a net revenue of 7 cents per passenger mile after deducting 3 cents per passenger mile for electrical energy cost, vehicle amortization (Maglev-2000 vehicles are much lower in cost than airplanes), and personnel.

3. HSR will not significantly contribute to meeting future U.S. transport needs. Maglev-2000 will result in significant reductions in auto, truck, and air transport. **Exhibit D-2** shows the total passenger miles and truck ton-miles for the existing modes of transport in the U.S., plus projections of what HSR and Maglev could do if implemented.

Exhibit D-2 Annual U.S. Passenger and Truck Ton Miles vs. Transport Mode

Mode	**Parameter**		**Basis**
Auto & SUV	2.7 Trillion	Vehicle Miles	Statistical Abstracts (1.5 Passengers/vehicle)
	~ 4 Trillion	Passenger Miles	
Air	745 Million	Passengers Emplaned	U.S. Statistical Abstract (2006 Values)
	797 Billion	Passenger Miles	
Amtrak	25 Million	Passengers Carried	U.S. Statistical Abstract (2006 Values)
	5.4 Billion	Passenger Miles	
Intercity Trucks	1.05 Trillion	Ton Miles	U.S. Statistical Abstract (2006 Values)
HSR	80 Million	Projected Passengers	11 HSR Systems
	16 Billion	Projected Passenger Miles	20,000 Pass/Day; 200 miles average
Maglev	2 Billion	Projected Passengers	Projected for 25,000 mile National Maglev Network
	800 Billion	Projected Passenger Miles	
	500 Billion	Projected Intercity Ton Miles	

Even if 11 HSR systems are built in the U.S., and in the unlikely event that each system were to carry 20,000 passengers daily, the maximum ridership in Europe (most routes are substantially less), HSR would only handle 16 Billion passenger miles, 1/50th of domestic air travel. 2% of the U.S. air travel market. What good would that be? How would it contribute in any significant way to U.S. transport needs?

In contrast, the 25,000 mile National Maglev Network would capture most of the U.S. domestic air travel market, most of the intercity truck market, and a large fraction of the long distance automobile trip market because drivers will be able to take their personal autos with them if they want to.

4. HSR will not generate U.S. high tech jobs, and will increase the U.S. trade deficit by imports of HSR equipment. Maglev-2000 will create hundreds of thousands of new high-tech jobs, and will greatly reduce the U.S. trade deficit by exports of U.S. Maglev equipment and by reductions in oil imports.

   HSR is a fully mature technology, with no opportunity to create high tech design and manufacturing jobs and profits will be in foreign countries. The only U.S. jobs will be construction jobs to lay rail and build stations. The high cost of importing HSR equipment will significantly increase the U.S. trade deficit, now at 700 Billion dollars annually. Moreover, HSR will not significantly decrease U.s. oil consumption, so that the 500 Billion dollars America spends per year on oil imports will not be reduced.

   Maglev-2000, in contrast, will create hundreds of thousands of new high tech jobs in designing and manufacturing Maglev equipment. Maglev will decrease the U.S.trade deficit, not increase it, by exporting Maglev equipment to other countries. The export value of Maglev equipment will be many Billions of dollars annually. In addition, by reducing oil imports, the 25,000 mile National Maglev Network will shrink the annual U.S. Trade deficit by hundreds of Billions of dollars.

   If the U.S. does not grasp the opportunity to develop a domestic Maglev industry, it will ultimately need to import foreign Maglev Systems, because HSR will not meet U.S. transport needs. One container ship can import 20 miles of prefabricated Maglev-2000 guideway along with Maglev-2000 vehicles. Instead of decreasing the U.S. trade deficit, and helping to restore the manufacturing industry in the U.S., HSR would continue America's manufacturing decline.

5. HSR average operating speeds in Europe are not much above 100 mph, when stations stops and accelerations/deceleration times are taken into account. Maglev-2000 offers much higher average speed because vehicles can accelerate and decelerate much more rapidly, and electronically switch at high speed to off-line stations. Also, Maglev vehicles offer much greater frequency of service because they travel as individual units, not as long trains of many cars that require waiting to accumulate many passengers for the train.

   The fastest average HSR speed in Europe is on the TGV Paris-Lyon line, at 130 mph. The maximum HSR speed is 220 mph. Average speed for HSR is significantly less than the maximum speed, because of intermediate station stops, and the low acceleration/deceleration rates for HSR trains, on the order of only 1/5th that of an automobile that goes from 0 to 60 mph in 12 seconds – a rather low rate for the average auto.

   Average HSR speeds are significantly lower for other European HSR lines. The new HSR line between Madrid and Seville has a somewhat lower average speed of 120 mph. The Eurostar train between London and Paris for example averages 110 mph, not much greater than the Boston-Washington Acela trains, which averages 83 mph.

At 130 miles per hour, it would take 20 hours for an HSR train to travel from NYC to Los Angeles compared to about 9 hours by air, when the security time is included.

The average speed on Maglev-2000 routes will be much greater, because the vehicles can electronically switch at full speed to secondary guideways that lead to off-line stations. Traveling on Maglev-2000, the passenger vehicle would bypass stations at high speed that it was not scheduled to stop at, providing, non-stop service for most passengers. Moreover, the Maglev vehicles can easily accelerate as fast as automobiles, eliminating the long time to attain speed required by HSR trains. With a maximum speed of 300 mph for Maglev-2000 vehicles, average speeds of 250 mph can be readily achieved, enabling a cross-country trip in only 10 hours – twice as fast as HSR, and almost as fast as air.

Since Maglev vehicles can travel as individual units with 100 passengers, instead of long HSR trains with many cars and many hundreds of passengers (The EuroStar has 800 passengers per train), travelers on Maglev will not have to wait more than a few minutes between Maglev vehicles instead of hours, as often is the case for HSR trains.

6. HSR will not significantly reduce U.S. oil consumption. The 25,000 mile National Maglev-2000 Network, in combination with electric autos, can eliminate most of the oil imports to the U.S.

Although HSR trains are electrically powered, this will only meet a very small percentage of U.S. transport demand, and consequently have very little impact on U.S. oil imports. The U.S. currently consumes about 5 billion barrels of oil per year for transport, with another 2.5 Billion barrels going for industrial and residential use.

The recent Oak Ridge study on energy use for transportation shows an average consumption of about 6 barrels of oil per 10,000 passenger miles for both air and auto transport. On this basis, 16 Billion passenger miles for HSR transport in the U.S., 3 times greater than the 5.4 Billion passenger miles presently supplied by Amtrak, would only save 10 million barrels of oil per year, just $1/500^{th}$ of what America presently consumes for transport – a trivial amount in terms of reducing oil imports.

In contrast, Maglev-2000, in combination with electric autos, can save several billion barrels of oil annually, the 25,000 mile National Maglev Network would transport the bulk of the long distance movement of passengers and freight by air, autos, and trucks. Short local trips of 50 to 100 miles would be provided by electric automobiles. Maglev-2000 would enable travelers to take their personal autos with them in long distance trips, if they wanted to do so.

7. HSR will not significantly reduce U.S. greenhouse gas emissions. The 25,000 mile National Maglev-2000 Network, in combination with electric autos, can reduce CO_2 emissions by 20%.

CO_2 emissions from the U.S. transport sector are approximately 2 Billion tons per year, about the same amount as from U.S. coal fired power plants, and one-third of all U.S. CO_2 emissions.

HSR trains, as noted in reason #6, would only save $1/500^{th}$ of present U.S. transport oil consumption, so are related reduction in CO_2 emissions would be $1/500^{th}$ x 1/3 or 0.07%. HSR has virtually zero effect on U.S. greenhouse gas emissions.

Maglev in combination with electric autos, on the other hand, can cut U.S. CO_2 emissions from 2 Billion tons per year by a factor of approximately 2/3, resulting in a reduction of 20% from the total current emissions for the U.S.

Maglev would provide most of the long distance trips now made by oil fueled trucks, airplanes, and autos. Electric autos would be used for short local trips of 50 to 100 miles between recharging. For travelers wanting to take their autos with them for long trips, they could take them on Maglev vehicles, at lower cost and much more rapidly than by driving.

The future reductions in CO_2 emissions by implementing Maglev would be much larger than the ~ 1 Billion tons savings based on current transport levels. Passenger miles and truck ton miles are projected to almost double in the next 20 years as the U.S. population grows and living standards improve. In addition, as oil supplies shrink, it will be necessary to manufacture synfuels from coal and oil shale, if the U.S. continues to depend on oil-fueled transport (Biofuels can only supply a tiny fraction of U.S. transport fuel needs). Manufacturing a gallon of synfuel from coal or oil shale doubles the effective CO_2 release to the atmosphere, as compared to extracting conventional oil from the ground and using it for transport.

The growing U.S. transport demand plus the use of synfuels to replace depleting conventional oil would increase U.S. CO_2 transport emissions from the current 2 Billion tons per year to 8 Billion tons per year, if the U.S. continues to rely on oil fueled transport. U.S. total CO_2 emissions would essentially double from 6 billion tons per year to 12 billion per year. Maglev will prevent this increase from happening.

8. HSR trains are extremely noisy and cause excessive noise levels to disturb people who live along the HSR route. Maglev travel is very quiet and will not bother people along a Maglev route.

   Steel-wheel on rail noise is highly objectionable to people who live near rail lines and a major factor in local opposition to installation of new rail lines. Maglev vehicles do not contact the guideway, and produce no mechanical noise. There is some aerodynamic noise at very high speeds; however, in the Maglev-2000 system the high-speed intercity vehicles operated on guideways alongside the Interstate Highways, and the Maglev noise levels are well below those levels that already exist on the Interstates. In the urban/suburban portions of metropolitan regions, the maximum Maglev speed will be 100 mph, with noise levels far lower than those for commuter and light rail. In fact, since Maglev will use existing rail lines in urban/suburban areas, with the very quiet levitated Maglev vehicles making no rail noise. Local people will welcome the conversion to Maglev.

9. HSR, when compared with U.S. Maglev, falls short of the mark in four critically important National missions areas: (1) rapid all-weather, evacuation and supply of areas hit by a natural disaster, (2) rapid shipments of goods and people in support of the Defense mission, (3) stabilization of the electricity supply by efficient storage of electricity for use when demand is high or interruption of electric service by failure of the grid, and (4) the capability to transport billions of gallons of water to supply dry areas.

   HSR will not be able to significantly evacuate large numbers of people from metropolitan areas that experience natural disasters, or a chemical, biological or nuclear terrorist attack. As evidenced by Hurricanes Katrina and Rita, there exists no effective way to evacuate large numbers of people from stricken metropolitan regions like New Orleans, Houston, and most of the major population areas in the U.S. Roads get jammed with cars, autos run out of gas, accidents occur, etc.

   High Speed Rail cannot serve as an emergency evacuation system in America. The passenger capacity is too small and most cities would not be served by High Speed Rail lines.

However, with the 25,000 mile National Maglev Network that interconnected all of the major metropolitan regions in the U.S., large numbers of refugees from a stricken area could be transported to many different cities, easing the load on each of the refuge points. For example, by coupling 5 Maglev vehicles into a single consist with 1 minute headway between consists, and 160 people per vehicle, 50,000 people per hour could be transported to many other cities on the network or 1.2 million people per day. Highways could not begin to handle that load, no could airways,, conventional rail, or high-speed rail.

High Speed Rail can only transport passengers and not freight. Conventional rail averages only about 20 mph in moving freight across country, plus the long periods needed to lead up the many cars on a typical freight train. In contrast, Maglev can move freight at 300 mph across country, and transport it on single vehicles. This fast transport is extremely important for moving materiel that would be vitally needed for National Defense.

High Speed Rail has no role whatever for energy storage of electricity. In contrast, Maglev vehicles can b e used to store many hundreds of megawatt hours of electrical energy by transporting heavy concrete blocks from a lower to higher elevation, and returning the electrical energy to the grid by transporting them back downhill converting their stored potential energy back to electrical power. The cost of storing electric energy using Maglev is very low, only about 2 cents per kilowatt hour, compared to the typical power cost of 10 or more cents per kilowatt hour.

Maglev energy storage units can be located anywhere in the U.S. In hilly terrain, they would use the natural differences in elevation, with a guideway going between higher and lower elevations for the transport of the concrete blocks. In flat terrain they would use an underground shaft or inclined tunnel in which the blocks would move.

Maglev energy storage can be used to stabilize electrical grids, so that damage to an individual transmission line or a power plant would not shut down a large regional grid.

Maglev energy storage can also be used to store electrical power form highly variable solar and wind power sources. So far, there has been no practical way to store wind and solar power other than pumped hydro, which is very limited in locations where it can be applied. Maglev energy storage will enable solar and wind power to play a much greater role in U.S. energy production.

Finally, Maglev can transport very large volumes of water, billions of gallons per day, over long distances, hundreds of miles, at much lower cost than by pipeline, with much lower power requirements, Maglev could dramatically help water scarce regions like Nevada, Southern California, and Arizona meet their water needs.