U.S. ADVANCED FREIGHT AND PASSENGER MAGLEV SYSTEM

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SUMMARY

Japan and Germany will operate first generation Maglev passenger systems commercially shortly after 2000A.D. The United States Maglev systems will require sophisticated freight and passenger carrying capability. The U.S. freight market is larger than passenger transport. A proposed advanced freight and passenger Maglev Project in Brevard County Florida is described. Present Maglev systems cost 30 million dollars or more per mile. Described is an advanced third generation Maglev system with technology improvements that will result in a cost of 10 million dollars per mile.

Global Maglev Technology

Gordon Danby and James Powell proposed the first practical Maglev concept in 1966. This first generation transport concept included lightweight and powerful superconducting magnets that would levitate and propel a vehicle by inductive interaction with a guideway that contained normal aluminum wire loops at ambient temperature. During 1969 through 1971 they also developed and described the concepts of the null flux configuration and linear synchronous motor which have been developed by Japan into their Superconducting Linear Motor Express System.

Superconducting Maglev systems such as the recent and third generation American Maglev Star Inc. (AMS) system achieve large 6 to 8 inch clearances between the vehicle and guideway.

The magnetic fields are inherently and strongly stable against any external force such as wind gusts, up and down land grades, curves, etc. This type of system can be designed to have very low magnetic drag and switch to different guideways at full operating speed while being propelled at high efficiency using a small AC current in the guideway.

Japan is presently building, in Yamanishi Perfecture, the initial 25 miles of a 300 mph, 300 mile long Tokyo to Osaka Maglev route. Germany has developed an alternate Maglev technology approach based on attracting magnetic forces between conventional electromagnets and ferromagnetic iron rails operating at ambient temperature. Electromagnets as compared to superconducting magnets are severely constrained by electric power consumption. The clearance between the guideway and vehicle therefore is only about 3/8 inch. Superconducting Maglev is strongly stable against all conceivable external forces. Electromagnetic Maglev is inherently strongly unstable. Guideway contact is only prevented by sensing the gap and adjusting current by milliseconds in the vehicle electromagnet windings so as to counteract any movement towards or away from normal suspension points. Plans to build a 175 mile Transrapid line between Hamburg and Berlin should result in system operations around 2004 AD.

During the late 60's to early 70's the United States started several small Maglev study programs that were discontinued. The U.S. restarted several small study efforts a few years ago under the National Maglev Initiative and authorized under ISTEA a full scale prototype development program, but due to budget deficit constraints, work on U.S. Maglev has again been halted. The only Maglev development work currently under way is taking place in the state of Florida as a direct result of the efforts of the Florida Department of Transportation.

Benefits and Capabilities of Maglev Systems

Benefits of Maglev transport systems include 1) more energy efficiency than automobiles and airplanes (Figure 1); 2) much less polluting to the environment (Figure 2); 3) independent of oil supply and imports; 4) much lower transport costs; 5) capable of carrying larger capacity of passengers along given corridors; 6) shorter travel times over moderate distances; and 7) not affected by bad weather.

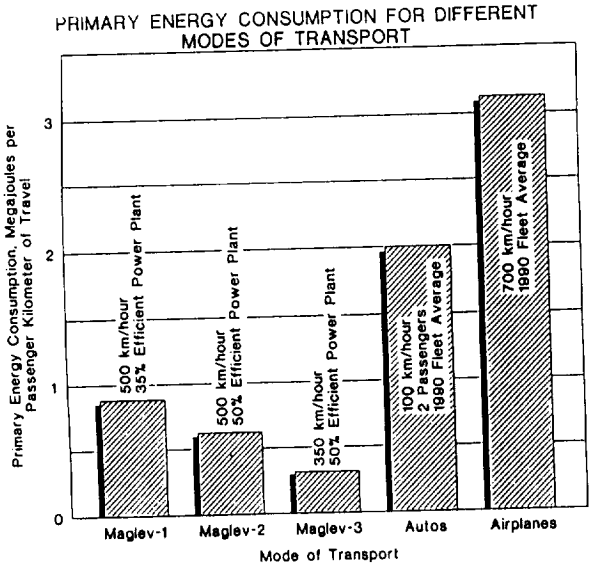

Figure 1
Transport Energy Consumption

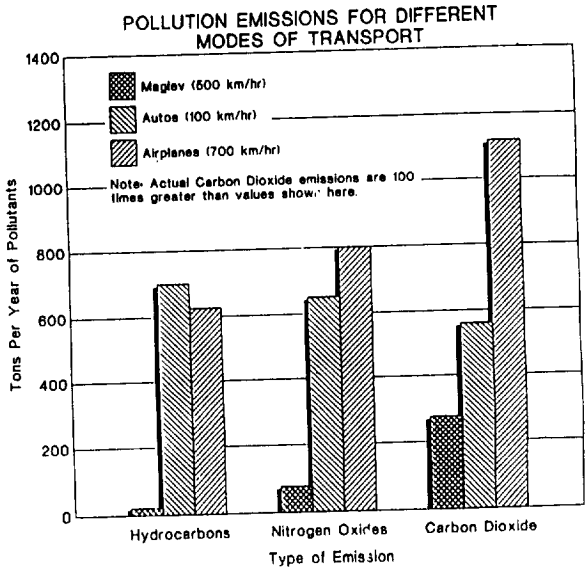

Figure 2
Transport Pollution Emissions

Figure 3 shows that intercity transport accounts for slightly more than one-half of the current annual U.S. outlay. Intercity freight transport out-lay is almost 4 times greater than that of air passenger travel. At 177 billion dollars per year versus 50 billion dollars, Maglev market potential is much greater for intercity truck type freight than intercity passengers. Policy makers, transportation proponents including analysts, Maglev designers and builders should realize this fundamental fact. Maglev is still being viewed primarily as a passenger carrier instead of a freight carrier with the secondary role as a passenger carrier.

Average intercity passenger trip distance is around 600 miles. Average intercity truck haul distance is 400 miles. AMS vehicles could carry containerized freight as well as passengers. A Maglev vehicle carrying truck trailers or containers would be about 10% heavier but it could travel on a common guideway along with passenger vehicles. This type of vehicle comparison is shown in Figure 4. "Roll-on, roll-off" trailer and container technology is common both domestically and internationally. Channel trains take advantage of the concept. Operating costs including energy, vehicle amortization and system, for freight and passenger transport are shown in Figure 5. These costs are approximately 20 to 25% of the air and truck transport operating costs. The guideway amortization costs are inversely proportional to the traffic carried and are not included.

U.S. OUTLAY AND DEMAND BY TRANSPORT MODE

INTERCITY TRANSPORT MODE	1992 OUTLAY (B $ / YEAR)	1992 DEMAND (BILLION TON MILES OR PASSENGER MILES/YEAR)	NOTES
Passenger Auto	260	1663	½ of Total Auto 46¢ Per Vehicle Mile
Truck Freight	177	815	22¢ Per Ton Mile 400 Mile Avg. Haul
Air Passengers	49	367	12.5¢ Per Passenger Mile 1000 Miles Avg. Trip
Rail Freight	31	1107	3¢ Per Ton Mile (Bulk) 700 Mile Avg. Haul
Air Freight	15	11	1.30$ Per Ton Mile
Rail/Bus Passenger	4	38	10¢ Per Passenger Mile

Source - 1994 Statistical Abstracts

Figure 3
U.S. Outlay and Demand

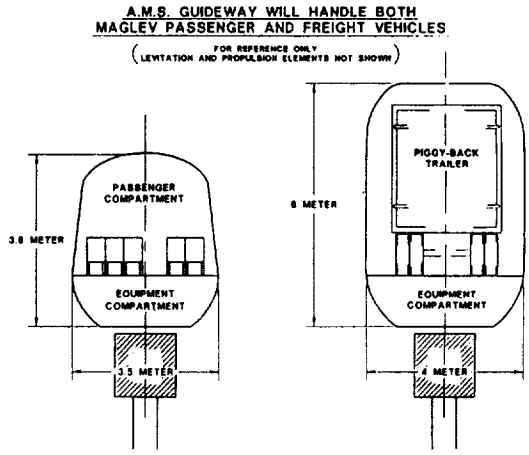

Figure 4
AMS Guideway Will Handle Both Freight and Passengers

Guideway payback depends on the traffic volume as shown in Figure 6. Traffic loading as shown above is achievable in many locations in the United States. Freight and passenger systems that carry on the order of 1,000 trailer equivalents a day and 10,000 passengers a day result in a pay back period of about 4 years. Figure 7 shows a 16,000 mile National Maglev Network that connects virtually all of the 100 largest metropolitan areas in the U.S. Present transport systems operate as networks and so Maglev systems should be viewed in the same way. The Network indicates that 70% of the population live within 15 miles of a maglev station and 95% in the states served by the network.

OPERATING COSTS FOR MAGLEV TRANSPORT

COST COMPONENT	PASSENGERS (CENTS/PASSENGER MILE)	TRAILER FREIGHT (CENTS/TON MILE)
PROPULSION ENERGY (80% EFFICIENT LSM)	0.53	3.5
VEHICLE AMORTIZATION	1.14	2.7
MISCELLANEOUS (INCL. PERSONNEL)	1.3	1.0
TOTAL	3.0	7.2
BASIS:	5 M $ VEHICLE 5 YEAR WRITE-OFF 100 PASSENGERS (2/3 OF MAX. CAPACITY) 40% DUTY FACTOR 250 MPH AVERAGE SPEED C_D = 0.20 L/D_{MAG} = 100 A_F = 10 M^2	3 M $ VEHICLE SAME 1 TRAILER (25 T PAYLOAD) SAME SAME SAME SAME A_F = 18 M^2

Figure 5
Maglev Transport Operating Costs

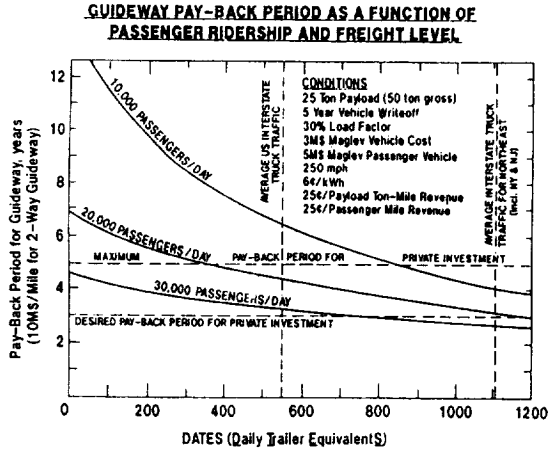

Figure 6
Guideway Pay-Back Period

Two principal Maglev implementation requirements are needed. One is cost and the other is ability to switch vehicles off-line that are traveling at full operating speed on the main guideway. Both requirements are achievable.

First generation Maglev guideway costs are on the order of 30 million dollars per mile. AMS designs are based on narrow beam and pier guideway technology which can be mass produced and prefabricated at local factories and shipped to construction sites for rapid assembly. This is shown in Figure 8. A projected AMS guideway cost for two way travel is around 10 million dollars per mile.

Figure 9 shows the AMS format for high speed switching technology which is the second requirement. It includes a specially shaped guideway at high speed switch locations and it is possible to divert 300 mph vehicles from the main guideway onto the secondary guideway where deceleration, unloading and loading would take place. After operations are complete the vehicles would accelerate up to 300 mph and enter the main guideway. In this way vehicles could either stop at or skip stations.

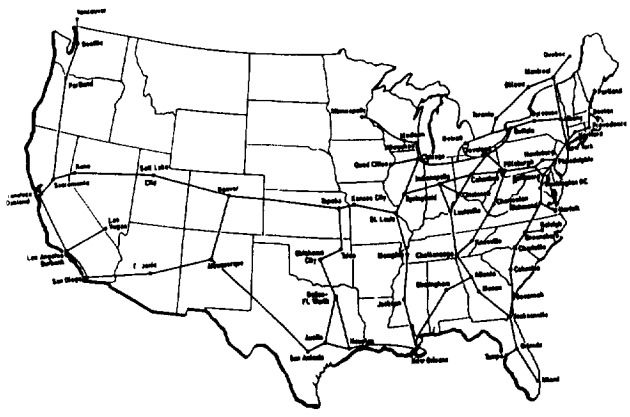

Figure 7
National Maglev Network

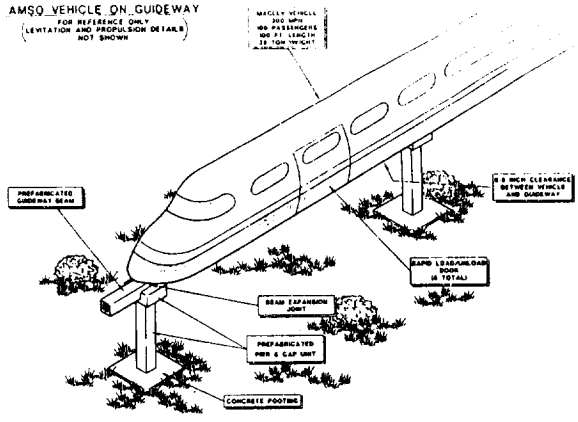

Figure 8
Narrow Beam Guideway

Development of an Advanced Maglev Industry in the United States

Although the U.S. was the leader in establishing the concepts for advanced superconducting magnet Maglev it starts from far behind in the Global Maglev race. However high speed transportation technologies are being incubated in the state of Florida and if a vigorous program were to be pursued, there is still time to catch up and "leap-frog" to a more advanced third generation system. The U.S. has advanced engineering and industrial capability to achieve this more advanced system, but budget problems appear to prevent the government from taking the leading role. The only alternative is private, public partnerships where the private sector assumes the role of technology developer and shares the burden with the public sector.

American Maglev Star Inc. is following this approach in the Brevard Count Florida Project. AMS has proposed a 20 mile Maglev transportation system to demonstrate the new advanced technology. The system would run between Port Canaveral in the east to TICO airport in the west with an intermediate stop planned at the Kennedy Space Center Visitors Center, as shown in Figure 10. This route appears to have sufficient ridership potential that it could return its investment in a reasonable period and it has strong local and state backing.

The project is planned to start with a phased program. The AMS technology development is already benefiting Brevard County and the state with spin-off industrial applications in the area of advanced superconducting and normal magnets, conductor and related electromagnetic applications that include transportation, medical MRI, power storage (SMES), high energy physics accelerators and others.

The phased program will contain three levels in the development work plan. Level 1A will include the development of electromagnetics and a full scale mockup. Level 2A will result in the fabrication of approximately 85 meters of smart guideway including advanced infrastructure. The National High Magnetic Field Lab in Tallahassee will provide support for the development of high temperature superconductors as coils for Maglev magnets. The National Aviation and Transportation Center will provide multimodal simulation support and local Brevard County as well as national industry will provide additional technology development support.

In the level 2 phase AMS proposes to lengthen the guideway to 250 meters and construct a full scale, short and light Maglev vehicle that will operate at speeds to around 100Km/h.

In the level 3 work plan phase a full demonstration of Maglev transportation system components is planned. A high speed switch would be installed on an extended guideway of 2,500 meters. A full scale freight and passenger simulator vehicle would be fabricated and operated through the switch at 300 Km/h. At the completion of level 3 of the phased program the AMS technology would be ready for certification and validation of the system operating and safety parameters.

Then with private and other investments to start the 20 mile project, it appears that this system could be the demonstrator for an advanced U.S. Maglev System that could then be implemented at many locations throughout the Nation.

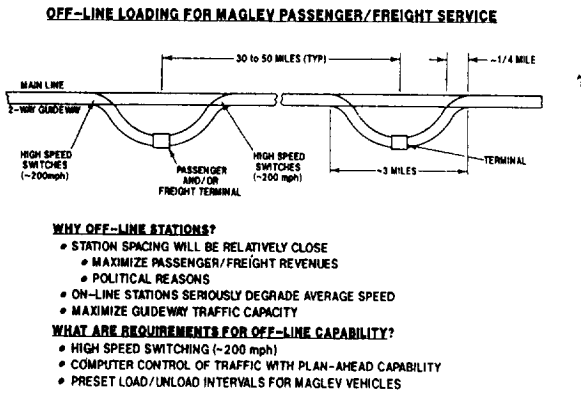

Figure 9
High Speed Switch

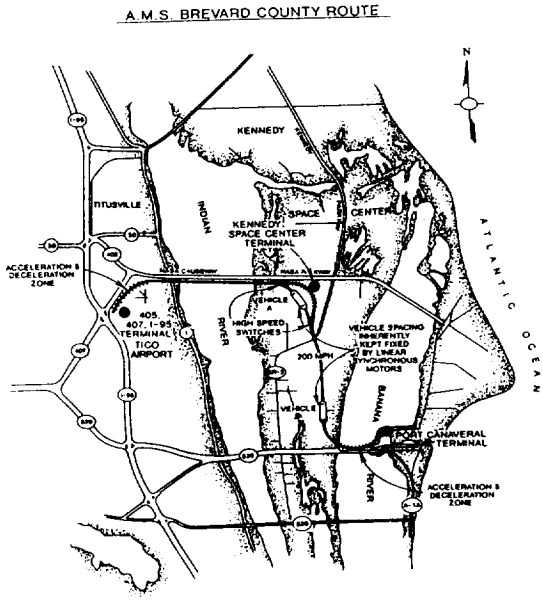

Figure 10
Proposed AMS Brevard County Maglev Route

Session 5 -- Controls 1

Chairman: Bibhuti Banerjee
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