CHAPTER 5

Federal Policy Issues for maglev and tiltrotor

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Although new technologies, including magnetically levitated **(maglev)** vehicles and tiltrotor aircraft, are being developed that could help make our transportation system work better, these new technologies alone will not resolve current congestion and environmental difficulties. Transportation problems are due more to investment, land-use, and management policies and practices than to inadequate technologies,[1] and any technology change must be accompanied by appropriate policy changes, or the benefits may not be realized.[2] Furthermore, changes by any group of users, such as airlines or automobile commuters, to optimize their operations within a new policy and technology framework are difficult to forecast but likely to alter the long-term impacts of technology-based standards and policies.[3]

This study outlines the roles that maglev, tiltrotor, and other advanced technologies could play in improving intercity transportation. Tough decisions about complicated policy and transportation management issues must be made before development and operation of the technologies can proceed on a large scale in the United States. Moreover, a significant realizable market for these systems does not now exist domestically. Appendix B summarizes general conclusions on transportation system management, research, and technology from a recent OTA study. This chapter addresses the specific issues that affect the viability of tiltrotor and maglev.

Findings

- maglev and tiltrotor concepts are technically feasible. Prototype vehicles have operated in the United States or abroad for more than a decade. Once installed, these new modes could operate at speeds that would provide door-to-door trip times competitive with conventional air transport at distances up to 500 miles. maglevs and tiltrotors could avoid airport ground access and runway delays and offer terminals closer to population or industrial centers. If the maglev or tiltrotor vehicles depart as frequently as airliners, they could save time compared with travel by conventional air on a particular route. Developing tiltrotor or next-generation maglev systems to the point of being commercially viable would cost billions of dollars.

- Neither technology has been demonstrated as practical for intercity passenger service and the realizable market for tiltrotor or maglevtechnologies is subject to a variety of factors whose impacts are difficult to predict. The busiest air travel routes are the primary target markets cited by both maglev and tiltrotor proponents. However, potential entrepreneurs will face significant community and institutional barriers (see table 5-1) to establishing new transportation systems, and such issues are time-consuming and potentially costly to resolve. Moreover, if an intercity maglev, tiltrotor, or high-speed rail system is put into place, their operators will have to compete with the marketing power and pricing flexibility of the large airlines.

- Furthermore, maglev and tiltrotor systems will be expensive to establish—tiltrotors would cost more per seat to purchase and operate than conventional airplanes, and maglev routes would need 3 to 5 million passengers per year just to cover a 20-year amortization cost of the guideway at typical air travel fares. **Thus, time-sensitive service, such as business travel, is likely to be the initial market niche for maglev and tiltrotor, if most of the capital and operating costs are to be covered by ticket sales. It is not clear that either**

1 U.S. Congress, Office of Technology Assessment, Delivering the *Goods: Public Works Technologies, Management, and Financing OTA-SET-477* (Washington, DC: U.S. Government Printing Office, April 1991), p. 129.

2 Ibid., p. 33.

3 Ibid.

Table 5-l-Steps Still Needed for Operational maglev or tiltrotor System

	Commercial tiltrotor	Maglev
Technology development . .	Military V-22 program engineering and operating experience; noise, flight path, and cockpit research.	Debate revolves around whetter to develop new U.S. designs or develop or buy foreign concepts. low-cost guideways and reliable switches are desirable.
Infrastructure	Conveniently located vertiports; terminal airspace, routes, and procedures; air traffic control (ATC) and navigation facilities.	Available and affordable rights-of-way; dedicated guideways, bridges, grade separations, electrification, communication and control systems, and stations.
Technology and safety demonstration	ATC compatibility; community noise levels; economic data; airline and passenger acceptance.	Construction methods; construction, operating, and maintenance cost data; community and passenger acceptance.
Federal regulatory structure	Mostly exists--specific airworthiness and operating standards for tiltrotors are being developed. Initial vertiport standards have been published.	Not yet developed-some maglev design and performance characteristics conflict with current Federal Highway Administration (FRA) regulations. FRA is assessing the applicability of current statutes and regulations to the Orlando maglev and developing waivers, guidelines, and possibly new regulations for the. project. The Orlando project will be the basis for future maglev regulations.
Legal and environmental concerns	Noise standards; local zoning.	Noise during very high speeds; right-of-way agreements; possible health effects of electromagnetic fields.
Financing	Under existing policies, Federal support for infrastructure possible but not for aircraft development.	No Federal policy for funding maglev or high-speed rail technology development or infrastructure.
Competitive framework	Airline cooperation is essential for tiltrotors to operate. Individual airlines have well-established operations in highly competitive short haul markets and see mostly risks and no additional profits in employing tiltrotors. The higher direct operating rests of tiltrotor service might have to be underwritten if tiltrotors are to provide public benefits of expanded airport capacity and reduced delays and congestion.	Airline marketing power and large, established route structure could be strong assets or formidable opponents to intercity maglev. Amtrak has operating authority for most routes proposed for passenger-carrying maglev or high-speed rail.

SOURCE: Office of Technology Assessment, 1991.

of these types of services will provide enough relief for intercity congestion and delays to serve as a cost-effective investment for Federal transportation dollars. However, without some public willingness to finance infrastructure, neither technology will be realized as an option.

- tiltrotor and maglev could enhance other transport operations, in addition to intercity commercial travel, and might warrant Federal support. While tiltrotor has been developed primarily for military missions, it might also fill other public roles, such as emergency evacuation, or serve industry needs, such as offshore oil rig support. maglev carries passengers on short, low-speed transit lines in Germany and England, and regional transit or commuter service might be feasible if maglev's potential for low maintenance costs is achieved.

- Congress will need to clarify objectives for funding these technologies. Research, development, and demonstration investments for maglev and tiltrotor technology could be considered to support long-term strategic purposes, such as technology leadership and future mobility. tiltrotor, maglev, or other new transportation technologies could be cost-effective in certain locations if conventional options become insufficient or too expensive to meet future transportation needs. How maglev or tiltrotor development would affect the domestic economy or balance of trade depends on a variety of factors.

- Some form of Federal financing will be required if commercial maglev or tiltrotor technologies are to be developed by U.S. industry in the next decade. Foreign high-speed rail technology is available now for U.S. markets, and German maglev will be ready by late 1992. Public support for infrastructure—rights-of-way for maglev and specific air traffic control (ATC) and landing facilities for tiltrotor—would also be necessary, regardless of who advances and sells the technology.

- Developing maglev or tiltrotor technology and establishing operating systems in the next 10 to 15 years to help improve conventional transportation modes will need complementary Federal environmental, intermodal, and transportation management policies. Most forecasts project that passenger travel will continue to grow during the next 20 years, although future congestion levels are difficult to assess. For example, airline scheduling strategies rather than passenger demand determine how crowded the runways at most hub airports become. If congestion increases, tiltrotor, maglev, and other alternative transportation modes might help relieve some pressure on highways and airports. However, under current market conditions and policies, too few passengers would switch to these new modes to effect much change in automobile or airline operations. Moreover, shifting traffic from highways or runways that are clogged is usually a temporary solution, since other vehicles quickly move into any newly created openings. **Executive branch agencies will face additional safety, environmental, and economic oversight and regulatory responsibilities that must be supported if maglev, tiltrotor, or other comparable systems are placed in service.**

- If the Department of Defense (DOD) V-22 Osprey program is continued, enough engineering and operational experience might be gained for industry and investors to make firm decisions, either pro or con, regarding commercial tiltrotor production. Industry observers believe that the V-22 design is unacceptable for most commercial transport applications, owing to economic and civil performance penalties inherent in meeting military requirements, although some V-22 structural and propulsion designs and components might be directly transferable to a commercial tiltrotor. **Because it has worked closely with DOD to collect data from the V-22 flight test program, the Federal Aviation Administration (FM) is well positioned to certify a V-22 type of aircraft for civilian test and demonstration operations by late 1995, if a sponsor requests it.**

- The Federal Railroad Administration (FRA) has just begun developing a regulatory framework for maglev. That agency will be especially challenged by the decision to place maglev in service in Orlando, Florida, by the summer of 1995. FRA's technical and regulatory framework for maglev and other high-speed systems needs bolstering, regardless of where the technology is developed. Ensuring the safety of high-performance and technologically complex maglev systems may require more active oversight procedures, including a system safety approach for approving designs and Federal licensing of operating companies and personnel. **In the interim, FRA must continue collecting and analyzing data from foreign high-speed rail and maglev operations. Additionally, FRA's safety research and development (R&D) resources, strained by the workload of the current National maglev Initiative (NMI), will have to be strengthened to monitor and participate effectively in a full-scale maglev technology development program and in the implementation of high-speed rail systems now being considered by various States.**

Options for Research and Development

The U.S. military is testing tiltrotor aircraft, Japan and Germany are developing maglev technologies, and a Japanese company plans to produce small tiltwing[4] aircraft by 1997. These designs would be costly to

4 The similarities and differences between tiltwings and tiltrotors are discussed in ch. 3.

establish and unlikely to penetrate the intercity passenger markets in the United States. Other concepts might prove more cost-effective. However, these or similar transportation technologies will likely be used on a small scale within the United States during the next 10 years, and the Federal oversight agencies will have to be prepared to evaluate such systems. At issue is the Federal role in fostering maglev and tiltrotor technologies for commercial applications and ensuring the safety of systems proposed for use in the United States.

Both maglev and tiltrotor could be included in a comprehensive Department of Transportation (DOT) research program into technological and system solutions to mobility problems. Maintaining a broad Federal transportation research base in these and other promising technologies, along with extensive data on passenger travel patterns, would assist in deciding on and gearing up for a larger scale development effort if conditions warrant it.

Foreign competitiveness implications of maglev and tiltrotor have been raised repeatedly in testimony to Congress, and Congress may consider making national leadership in either of these technologies an explicit goal. (The international context of such a technology policy goes beyond the scope of this study.) The United States has a significant worldwide lead in tiltrotor technology, and military, commercial, and public service applications have been identified for high-speed vertical takeoff and landing (VTOL) aircraft. Much tiltrotor technology development, engineering, and flight testing is directly transferable across the tiltrotor mission concepts, and other countries are seriously considering tiltrotor (or similar technology) programs. The extent of a global market is uncertain, but niche markets appear to exist. Therefore, the United States could have a favorable balance of trade in this product class if it is brought to market soon.

Things are different for maglev. Technology leadership is also an issue, but in this case Germany and Japan have the lead. German maglev could carry revenue passengers in the United States by 1995, and Japan has committed to spending $3 billion over the next decade to develop and test maglev technology. The world market for U.S.-produced maglev is uncertain. Most countries that could consider investing in maglev systems in the next two decades-Western European nations and Japan—have strong commitments to home-grown maglev and high-speed rail technologies. Even Germany, which invested substantial public funds to develop maglev, is implementing high-speed rail, not maglev. However, if enough Federal support is available to develop one, a U.S. maglev system could compete for these markets over the long term or in regions elsewhere in the world.

If Congress wishes to regard the trade balance as an issue affecting maglev, the complexities need to be closely examined. The largest component of a maglev is infrastructure-rights-of-way, guideways, and stations-and infrastructure is generally not exportable. Regardless of where the technology originates, 75 to 90 percent of the expenditures would go to construction and engineering firms that put the maglev infrastructure in place. U.S. firms could compete for this construction in foreign countries, but a government often gives preference to domestic firms. In addition, any government is likely to prefer vehicles to be produced domestically if a large enough market exists.

tiltrotor Development Priorities

Policies and an institutional framework currently exist for Federal R&D for aviation, and a dedicated funding source, the Aviation Trust Fund, exists to support technology and infrastructure development to expand system capacity. Technologies that enhance safety and community acceptance are fundamental needs of all civilian VTOL aircraft-helicopters, tiltrotors, or others—and developing such technologies for aircraft and infrastructure falls within the purview of existing National Aeronautics and Space Administration (NASA) and FAA programs. However, substantial Federal funding for developing and testing tiltrotor technology would be necessary, on the order of $250 million over a 3-year period, if U.S. industry were to decide in the near future to produce commercial vehicles. Congressional approval would also be required. If Federal efforts in civil tiltrotor technology development are to continue or increase, the priorities are:

Continue Vertical Flight Research at NASA and FAA Including Certification and Regulatory Support-NASA and FAA conduct about $27 million annually in research activities, mostly advancing civilian and military helicopter operations. About $5 million goes specifically to tiltrotor investigations. FAA is also collecting engineering and test data from the V-22 flight test program, which will assist future certification work for tiltrotors and other advanced VTOL concepts. Because of the potential quantum jump in performance over conventional helicopters, consideration might be given to increasing the percentage of vertical flight research funds devoted to high-speed VTOL concepts.

Step Up Work on Vertical Flight Research To Address Issues Affecting Public Acceptance-Congress could encourage FAA and NASA to conduct R&D that would make VTOL aircraft and infrastructure more attractive to communities and airlines. The most important program goals are to improve rotor designs to reduce noise, ensure appropriate cockpit equipment and procedures, and to develop flight tests and any necessary equipment to permit the steep flight paths to and from landing facilities. Closer coordination than -has been customary would be required between NASA and FAA if such programs were instituted. One way to effect this would be to establish an advisory committee with an explicit charter to integrate the agencies' efforts. Such a committee could also be empowered to help set priorities for other current vertical flight R&D programs.

Test and Demonstrate tiltrotors in Civilian Operations—Tests and evaluations of tiltrotors in civilian/commercial operations, which would also aid in gaining community and airline acceptance and in verifying infrastructure requirements, will be essential before manufacturers will commit to commercial tiltrotor production. At a minimum, Federal support for tiltrotor demonstrations would include standard regulatory and ATC functions and providing XV-15 and V-22 tiltrotorvehicles. Operational demonstrations of civil aircraft straddle the line between long-term technology development and near-term commercial goals—the full Federal role is unclear. Unless Congress commits to and funds a national civil tiltrotor program, operational testing might be accomplished at best gradually with funding out of NASA and FAA vertical flight R&D budgets. However, without an established funding profile, larger tasks, such as quiet rotor design and flight validation, will not be taken on. An intensive 3-year tiltrotor research and demonstration program, as described in the NASA/FAA Civil tiltrotor Missions and Applications study,[5] would cost, on an annual basis, two or three times the amount currently allocated for all NASA and FAA vertical flight programs, or $60 million to $90 million per year.

maglev Development Priorities

maglev, high-speed rail, and other advanced surface transportation modes need to be considered together and in conjunction with possible implementation options. Since high-speed rail is a fairly mature technology and operational overseas, it is unclear that an economic advantage would come from Federal investment in developing new steel-wheel technologies. However, technology and infrastructure research efforts to aid in establishing new routes in the United States would have immediate impact, since high-speed rail vehicles are available now.

If its promise is realized, maglev will travel faster and cost less to maintain than high-speed rail. Congress supported the National maglev Initiative, a 2-year, $25-million program to evaluate the role maglev can play in the U.S. transportation system and to recommend further actions regarding R&D for a U.S. maglev system. The three-agency NMI team—DOT, the U.S. Army Corps of Engineers, and the Department of Energy —is to report its findings in late 1992. The Transportation Research Board is investigating possible applications of high-speed surface transportation systems in the United States and expects to release its results this year. If Federal efforts in maglev technology development are to continue or increase, the priorities are:

Complete the National maglev Initiative—Fund the program through its scheduled conclusion at the end of fiscal year 1992. Since the results of the NMI study will not be available for fiscal year 1993 transportation appropriations deliberations, Congress may wish to provide follow-on funding for the transition year for the most promising Federal efforts as it decides the near-term Federal role in maglev technology development. The results of NMI investigations will help in evaluating foreign maglev performance and are essential for deciding whether or not to commit major public funds for a U.S. maglev program.

5 Boeing Commercial Airplane Group et al., *Civil tiltrotorMi.xrions and Applications Phase IL The Commercial Passenger Market,* prepared for National Aeronautics and Space Administration and Federal Aviation Administration, draft final report, NASA CR 177576 (Seattle, WA: February 1991), ch. 7.

Address maglev, High-Speed Rail, and Similar Systems in Related R&D Programs When Possible—Research efforts to reduce the costs of materials and construction and limit the environmental effects of major infrastructure projects are critical to the future of new ground transportation systems in the United States. Research into communication and automation technologies may be relevant for maglev and high-speed rail operations, and understanding the health effects of electromagnetic fields is important for the future of all electrically powered transportation systems. Specific technology needs differ markedly between the two basic types of maglev and between them and high-speed rail.

Bolster FRA Regulatory Framework—Regardless of near-term decisions on U.S. maglev programs, an appropriate Federal regulatory framework will be essential for overseeing the safety of maglev and similar technologies. FRA has traditionally depended on industry to develop design and operating standards for rail. Congress may wish to encourage FRA to evolve new regulatory oversight policies and R&D programs to support this development over the long term and to develop institutional expertise to address maglev technologies. This is a top priority, since suitable regulations, operating standards, and safety R&D programs for maglev and high-speed rail do not presently exist at FRA. Technical and regulatory expertise at the Urban 'Mass Transportation Administration, the Volpe National Transportation Systems Center, and FAA could assist FRA, and some standards and regulations already in place in other countries might be utilized.

Establish an Institutional Framework for maglev Development— If Congress decides to fund further maglev technology investigations, it must select a Federal agency to lead the effort. Unlike aviation, for which NASA and FAA have well-established roles and funding for technology research, the home for maglev research is not as clear. The Rail Safety Improvement Act of 1988 designates FRA as the lead agency for maglev, but R&D funding within FRA has dwindled in the past decade and the agency would be hard-pressed to undertake a large-scale maglev development program in the near future.

For the ongoing NMI, each of the three member agencies has brought unique and valuable perspectives to the program. This partnership will be useful if Congress decides to continue low-level investigations without committing to a major technology development effort. But a large-scale maglev development program might call for a different institutional structure. Because maglev has applications and consequences across transportation modes (urban and airport transit, for example), DOT is a logical choice for Congress to designate to administer maglev development.

Test and Demonstrate maglev Technology—maglev vehicles and guideways, unlike the vehicles and infrastructure in other transportation modes, are intrinsically linked. For example, the German and Japanese prototype maglev vehicles can operate only on their own unique infrastructure.

Without a "standard" maglev guideway, technology testing will require separate facilities for each maglev configuration considered. Any research program, such as a post-NMI effort, must be crafted carefully so that a range of components and concepts can be studied at modest expense through the prototype stage, where significant further investment driven by infrastructure needs would be necessary to test and demonstrate vehicle operations. Moreover, because of the expense involved, large-scale testing and demonstration of U.S. maglev technology might have to be linked to a commitment to implement an operational system.

Options for Operational Implementation

Establishing new transportation systems is fundamentally a process of overcoming a series of barriers. Success may not depend on the inherent strength of a specific technology, or even the particular mode. Choices depend on public objectives and how active Congress wishes to be. The most pressing transportation problems call for changes in infrastructure investment and system management policies.[6]

If Congress decides that having an operating intercity maglevT or tiltrotor system in the next 10 to 15 years is an important goal, it will have to support the

6 Office of Technology Assessment, op. cit., footnote 1, p. 130.
7 The Orlando system will not be an intercity route, and Texas is considering high-speed rail, not maglev.

development of these technologies because neither system is yet perfected. The policy choices for operational implementation depend little on who develops the technology, although technology leadership often allows the home country to set standards, criteria, and procedures for applications.

Issues for Implementing Alternative Transportation Systems

In deciding whether alternative technologies are necessary for meeting future transportation needs, Congress must consider that new collateral policies for existing transportation modes may be required for ultimate success. Environmental or congestion management efforts might be required to help shift traffic to an alternative mode. Transportation infrastructure is costly and usually needs public support. Moreover, health, safety, and environmental guidelines and regulations for transportation operations are usually Federal responsibilities, although States and local governments can establish more stringent requirements.

Installing maglev and tiltrotor systems would expand overall mobility considerably. As other transportation modes—particularly highways and airports—become more congested, these additional transportation choices and increased capacity will become more valuable. Current data indicate that ticket prices higher than now charged by most airlines will be necessary if revenue from fares alone must cover full costs for establishing and operating these systems. Experience tells us that passengers are not likely to switch voluntarily from their current travel mode choices unless the value of time savings or other factors outweighs higher fares and any other extra costs. Congestion levels for highway and air travel might rise enough to make the higher relative costs for maglev or tiltrotor more attractive to consumers if no unforeseen changes in travel habits or technologies occur in the meantime.

Although each transportation mode offers advantages over the others in certain areas, overall system benefits, such as congestion reduction or energy/environmental gains, will not occur without additional, collateral policy changes. Significant latent demand usually exists for transportation infrastructure where substantial congestion occurs, and plenty of new conventional transportation service providers would be pressed to fill the vacancies left by any who choose to switch to maglev or tiltrotor. Additionally, Congress must consider whether a new system is to provide premium service only or to offer more affordable mass transportation, in which case additional public support may be necessary. Another question that needs to be addressed is whether a new transportation mode that vies for airline or highway passengers should be protected from anticompetitive practices. (Characteristics of some air and rail transportation modes are compared in table 5-2.)

Tiltrotor Operating System Options

Federal efforts to foster tiltrotor operations will enhance vertical flight in general, and maybe considered part of a broader policy framework. However, higher performance vehicles, such as tiltrotors and tiltwings, may prompt changes in ATC and landing facility infrastructure independent of other rotorcraft needs. Several steps are necessary for successful commercial vertical flight in the United States.

Support Infrastructure Development—Some of the air and ground infrastructure necessary for tiltrotor operations can be developed before commercial tiltrotors are available. Federal funds and policies already support public airfield construction and improvement, and any facilities built with tiltrotor in mind would be capable of serving most civilian rotorcraft. However, current funding guidelines do not address heliports built to tiltrotor standards, since civilian tiltrotors are not yet a certainty. Some communities that are planning heliports want them suitable for future needs, and suitable guidelines could be developed. For the marginal cost of meeting tiltrotor standards, it is prudent to build vertiports at locations where there is public support for them and public heliport construction is planned. Congress may wish to encourage FAA to clarify the present policy on vertiport funding.

Table 5-2-Intercity Transportation Technology Comparisons for the Northeast Corridor (NEC)

	Jetliner (128-seat B737-300)	tiltrotor (39-seat nonmilitary)	maglev (200-seat Transrapid)	High-speed rail (350-seat TGV)	Conventional rail (350-seat Metroliner)
Performance:					
Maximum speed	550 mph	350 mph	250 mph	185 mph	125 mph
Total trip time one-way between DC and NYC[a]	3.2 hr	1.9 hr	2.6 hr	3.0 hr	4.1 hr
Energy consumption	50-70 seat-miles per gallon (smpg)[c]	30-35 smpg	250 smpg	300 smpg	200 smpg
Economics: (for 10-million annual passenger trips in the NEC)					
Vehicle capital costs	$1.1 billion for 37 airocraft	$1.4 billion for 117 aircraft	$0.2 billion for 25 vehicles	$0.5 billion for 20 trainsets	$0.4 billion for 29 trainsets
Infrastructure capital costs[d]	Minimal new construction needed to handle NEC passengers	$0.5 billion for 12 vertiports	$7.2 billion for new guideway system[f]	$3.6 billion for new rail system[g]	$2.0 billion to upgrade rail system between Boston and NYC
Vehicle operating Costs[h]	7.1 cents per seat-mile	12.6 cents per seat-mile	3.4 cents per seat-mile	4.3 cents per seat-mile	4.9 cents per seat-mile

[a]The total time to travel door-to door from origin to destination is most important to time-sensitive passengers. Each travelercdd experience different delays (e.g., ground access, waiting at the terminal, mechanical difficulties) on each trip. The following assumptions were made for 1) average vehicle speeda~ 2) typical combined ground-access and delay time for the calculations shown in the table. Vehicle speed/access and delay--jetliner: 355 mph/149 minutes; tiltrotor: 310 mph/72 minutes; maglev: 200 mph/90 minutes; high-speed rail: 150 mph/90 minutes; Metroliner: 90 mph/90 minutes. Jetliner and tiltrotor estimates come from the NASA/FAA civil tiltrotor study: Boeing Commercial Airplane Group et al., Civil *tiltrotorMissions and Applications Phrase II: The Commercial Passenger Market,*prepared for National Aeronautics and Space Administration and Federal Aviation Administration, NASA CR 177576 (Seattle, WA: Boeing Commercial Airplane Group, February 1991); calculations for ground access and delays for rail and maglevcome from: John B. Hopkins, "Innovative Technology for InterCity Passenger Systems," *Passenger Transportation in High-Density Corridors* (Cambridge, MA: Volpe National Transportation Systems Center, November 1990), p. 44. The distance between Washington, DC, to New York City is roughly 200 miles; actual travel distance depends on terminal locations and routing.

[b]Energy use by each mode converted into equivalent gallons of jet fuel.

[c]Fuel efficiency of 75 to 100 smpg is feasible for new jetliners entering service after the year 2000, the earliest time that intercity tiltrotor or maglev could be established.

[d]Infrastructure for convetional aircraft and train Service exists. Tiltrotors could use current airways and air traffic control (ATC) facilities, but would need new landing areas for optimal service. maglev and high-speed rail require new guideways and supporting infrastructure; the calculations in the table assume 450 miles of new guideway for maglev or high-speed rail.

[e]Origin-to-destination air travel between the major airports in Washington, DC, Philadelphia, New York, and Boston presently accounts for around 10 percent of the total passengers and aircraft operations at those airports. Other air travel demands will be the major factors affecting airport and ATC infrastructure.

[f]Infrastructure formaglev, high-speed rail, and conventional rail include guideways, bridges, grade separations, electrification, signal/communication systems, and stations. The costs for a Transrapid maglev guideway system have been estimated at $10 million to $40 million per mile; $16 million per mile is assumed in the table.

[g]The capital costs for a new high-speed rail guideway system have been estimated at $4 million to $30 million per mile; $8 million per mile is assumed in the table.

[h]Includes crew, fuel, Vehicle maintenance, and vehi&f~anung(15 years with 8.5-percent interest with semi-annual payments). Does not include vehicle insurance and indirect operating costs such as passenger and baggage handling, sales, administration, real estate maintenance, and liability insurance. Assumes 3.4 billion seat-miles per year.

Table 5-2—Intercity Transportation Technology Comparisons for the Northeast Corridor (NEC)-Continued

	Jetliner (128-seat B737-300)	Tiitrotor (39-seat nonmilitary)	maglev (200-seat Transrapid)	High-speed rail (350-seat TGV)	Conventional rail (350-seat Metroliner)
Infrastructure amortization[i]	Not calculated[j]	1.3 cents per seat-mile	18.2 cents per seat-mile	9.1 cents per seat-mile	5.0 cents per seat-mile
Miscellaneous:					
Infrastructure use	Multiple operators of all aircraft types can use conventional airports	Multiple operators of most vertical takeoff and landing aircraft could use vertiports	Maglev guideways limited to specific vehicles; more than one common carrier per route feasible	High-speed rail tracks suitable for most nonfreight trains; current routes are restricted to single operators	Tracks are used by a wide range of trains, including local commuters
Other uses for vehicles	Military, corporate	Military, corporate, public service	Transit, commuter, airport connector	Airport connector	Commuter
Worldwide technology leaders	United States, Western Europe	United States	Germany, Japan	France, Germany, Japan	Europe, Japan, North America
Federal regulatory status	Well established	Within current framework; specific guidelines available	Existing rail regulations conflict with maglev characteristics; new guidelines are being developed	Some conflict with current rail regulations	Well established

[i] Amortization over a 20-year period with 6-percent interest and semi-annual payments; 3.4 billion seat-miles per year. Infrastructure operating and maintenance (O&M) costs are not included in this table. These costs are difficult to compare among different transportation modes as some infrastructure O&M costs are paid with public revenues and others are covered by private resources.

[j] Airport and ATC infrastructure cost billions of dollars to put in place. However, unlike the other transportation systems listed in this table, jetliners would not require new infrastructure to serve the NEC at the trip times indicated. See footnote e.

SOURCE: Office of Technology Assessment, 1991; and as stated in footnote a.

Some ATC procedures and technologies being developed by FAA for helicopter operations will also serve tiltrotors and tiltwings. Steeper approach paths[8] desired for tiltrotors, tiltwings, and commercial helicopters can be investigated with simulators and tested with available prototype aircraft and ground facilities, ensuring that a technically capable infrastructure could be in place for initial operators of advanced VTOL aircraft.

Establish Safety and Environmental **Criteria—** FAA is developing basic airworthiness and operating criteria for powered-lift vehicles (tiltrotor is one type of powered-lift) and is collecting V-22 data. These efforts should be continued and completed. Noise standards and guidelines for tiltrotors must be completed to aid in vertiport planning.[9]

Establish a Competitive Framework to the Extent Feasible—If a suitable vertiport network is put in place, tiltrotors may be able to compete on an equal basis with jet shuttle or other modes, and the market will decide its success. Increased flights into the ATC system, changed noise patterns, and increased energy consumption must be balanced against the time savings and increased mobility for air travelers when considering public policies for intercity tiltrotor service. Moreover, tiltrotors could increase airport capacity and productivity if they replace small conventional aircraft on a one-to-one basis and open runway slots for larger airplanes. Since tiltrotors are more expensive to operate than similarly sized commuter aircraft, airport feeder service may have to be subsidized in some form if tiltrotors are to replace commuters. One option is to use a common fund, such as the Aviation Trust Fund or an airport-specific account, to pay the cost differential for any operator who replaces a conventional aircraft with a tiltrotor if the public benefits justify it. While a major airline could gain from access to a new runway slot and might be willing to cross-subsidize tiltrotors out of fare revenues, it would have to be assured access to specific landing slots. Airline control of runway slots, however, remains a contentious issue. Any competitive market changes by airlines will also change the framework for tiltrotor.

maglev Operating System Options

If Congress wishes to promote intercity rail and maglev operating systems, there are steps it could take regardless of whether or not a specific technology is favored.

Establish a Right-of-Way Policy-Available and affordable rights-of-way are key to maglev and high-speed rail operational feasibility. Use of the median strips, shoulders, and air rights of interstate highways is one possibility considered for maglev. General support for intermodal use of interstate highways is being deliberated in current surface transportation reauthorization legislation, and Congress needs to resolve existing Federal statutory restrictions, which now require full reimbursement for use of interstate rights-of-way. However, it is unclear to what extent a high-speed surface transportation system could use highway rights-of-way laid out for speeds of 70 mph.

Establish Infrastructure Financing Policy—Unlike that for highways, transit, water transportation, and aviation, there is no Federal program for financing infrastructure for intercity maglev or high-speed rail, and thus extensive maglev or high-speed rail systems are unlikely to be built unless this policy is changed. Current State transportation funds are committed mostly to highway programs, although some States might be willing to offer tax advantages to help finance maglev or high-speed rail systems. Flexible use by States of current Federal surface transportation allocations is another possibility. A separate program of mATChing State support for high-speed rail or maglev systems is also an option. While small-scale State initiatives might be considered independent of specific technology, any financial commitment to a maglev system on a multistate or national scale requires an infrastructure standard for interoperability (i.e., like the interstate highway system). Various high-speed rail technologies, for the most part, can use common tracks. Differences are due mostly to maximum speed requirements.

Establish Federal Regulatory Guidelines for maglev Safety-Since States turn to the Federal Gov-

8 Although current helicopters takeoff and land vertically, they now fly shallow approach paths similar to airplanes.
9 Noise standards are established for helicopters (14 CFR 36) and heliport planning (14 CFR 150).

ernment for guidance on rail safety oversight, FRA regulatory policy for intercity high-speed rail or maglev systems must be expanded before such systems can be built. FRA is working with the States of Florida and Texas in preparing for their new systems. This effort will have to be expanded in scope if either of these technologies is to be implemented on a national scale. Issues of dedicated rights-of-way for passenger traffic and full-system safety requirements dictate rethinking of current FRA regulations, and Congress could consider encouraging such a change at DOT.

Establish a Competitive Framework—maglev and high-speed rail would be new entries into the high-speed intercity transportation market, which is presently dominated by large airlines. Airline marketing power and large, established route structure could be strong assets or formidable opponents to intercity maglev or high-speed rail. It is unclear what effect airline or Amtrak decisions could have on the prospects for private financing of maglevor high-speed rail projects, and this issue needs further study. The ongoing Texas high-speed rail project should prove a valuable case study for Congress.