# CHAPTER VIII
## Aviation

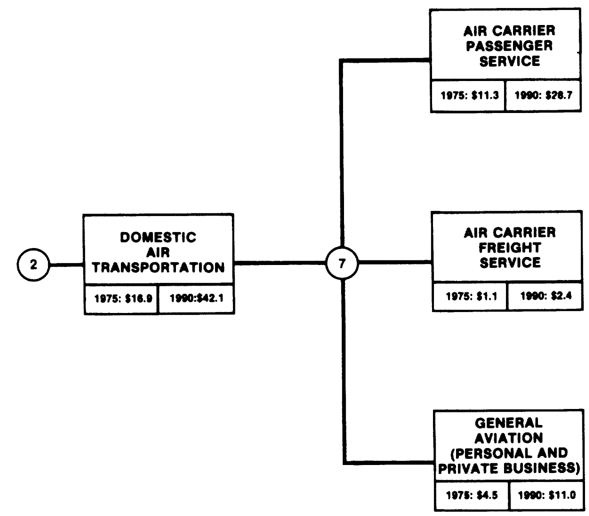
### INTRODUCTION

The place of America's aviation system in the Nation's transportation requirements may be seen in figure VIII.1. Air travel accounts for 13.2 percent of all intercity travel, 36 percent of all travel in trips of over 1,000 miles, and 96.0 percent of international travel. The net investment in our air system is currently estimated at $2.7 billion annually and the industry employs over a quarter of a million workers whose average salary is over $18,000 per year.

A common U.S. aviation system serves our commercial air carriers, general aviation, and the military. The Federal Aviation Administration (FAA) of the U.S. Department of Transportation answers for all safety aspects of operations (except accident investigation) and operates the Nation's air traffic control system. The Civil Aeronautics Board (CAB) administers (and enforces) regulations that control the commercial activities of the interstate air carriers. The types of users are shown in table VIII.1. These may be subdivided into the broad categories of air carriers, general aviation, and military aviation. Air carriers are companies that offer passenger or freight air transportation to the public. The certificated air carriers have CAB "certificates of public convenience and necessity," which authorize them to operate flights and to carry passengers, mail, and other cargo over specified routes. They also may operate charter or nonscheduled flights.

Subclasses of the certificated air carrier group are trunk and regional airlines. All trunk carriers have domestic and most have international operations. One (Pan American) has international operations primarily. For the others, except for Trans World Airlines, the international operations comprise a lesser part of total operations.

The glossary in figure VIII.2 differentiates among these users.




*NOTE: The amounts shown are the transportation bills for 1975 and 1990 in billions of 1975 dollars.*

**Figure VIII.1. Transportation Tree.**

**Table VIII.1**
**Users of the Aviation System**

| | |
|---|---|
| Air Carriers[1] | Certificated route carriers: |
| | Trunk airlines: |
| | Domestic operations |
| | International operations |
| | Regional airlines |
| | Domestic |
| | Trans-border |
| | Supplemental air carriers |
| | Commuter air carriers[2] |
| General Aviation | Commercial: |
| | Air taxi nonscheduled |
| | Nontransportation |
| | Business-executive transportation |
| | Instructional |
| | Personal transportation |
| | Other |
| Military Aviation | |

*[1]There are also additional classification such as helicopter carriers, domestic all-cargo carriers, and intrastate carriers.*
*[2]Commuter carriers are sometimes included under General Aviation-Commercial.*

One salient feature of aviation is its close coupling to technology. The advances of technology have driven the advance of aviation through the productivity improvements resulting from these innovations. From the introduction of multiengine reliability (i.e., the Ford Trimotor in 1926), the progression of civil aircraft has been one of constantly improving range,

**Air Taxi**

Any use of an aircraft by the holder of an Air Taxi Operating Certificate which operation is authorized by that certificate.

**All-Cargo Carrier**

One of a class of air carriers holding certificates of public convenience and necessity, issued by the CAB authorizing the performance of scheduled air freight, express, and mail transportation over specified routes, as well as the conduct of nonscheduled operations, which may include passengers.

**Business Transportation**

Any use of an aircraft not for compensation or hire by an individual for the purposes of transportation required by a business in which he or she is engaged.

**Certificated Route Air Carrier**

One of a class of air carriers holding certificates of public convenience and necessity, issued by the CAB, authorizing the performance of scheduled air transportation over specified routes and a limited amount of nonscheduled operations. This general carrier grouping includes the all-purpose carriers (i.e., the so-called passenger/cargo carriers) and the all-cargo carriers, and comprises all of the airlines certificated by the Board, except the supplemental air carriers. Certificated route air carriers are often referred to as "scheduled airlines" although they also perform nonscheduled service.

**Contract Operator**

An air carrier operating on a private for-hire basis, as distinguished from a public or common air carrier, holding a commercial operator certificate (issued by the FAA under FAR 121) authorizing the carrier to operate aircraft over 12,500 pounds for the transportation of goods or passengers for compensation or hire.

**Commuter Operators**

Operators of aircraft of a maximum size of 30 seats and a 7,500 pound payload, who perform at least five scheduled round trips per week between two or more points or carry mail. They operate under CAB Part 298, FAR 135, and at times FAR 121.

**Domestic Trunk**

One of a group of certificated route air carriers which operates primarily within and between the 50 States of the United States and the District of Columbia over routes serving primarily the larger communities.

**Executive Transportation**

Any use of an aircraft by a corporation, company or other organization for the purposes of transporting its employees and/or property not for compensation or hire and employing professional pilots for the operation of the aircraft.

**Foreign-Flag Air Carrier**

An air carrier other than a U.S. flag air carrier in international air transportation. "Foreign air carrier" is a more inclusive term than "foreign-flag air carrier," presumably including those non-U.S. air carriers operating solely within their own domestic boundaries, but in practice the two terms are used interchangeably.

**General Aviation**

All civil aviation activity except that of certificated route air carriers. The types of aircraft used in general aviation (G.A.) activities cover a wide spectrum from corporate multi-engine jet aircraft piloted by professional crews to amateur-built single-engine piston acrobatic planes, balloons and dirigibles.

**Industrial/Special**

Any use of an aircraft for specialized work allied with industrial activity; excluding transportation and aerial application. (Examples: pipeline patrol; survey; advertising; photography; helicopter hoist; etc.)

**Instructional Flying**

Any use of an aircraft for the purposes of formal instruction with the flight instructor aboard, or with the maneuvers on the particular flight(s) specified by the flight instructor.

**International and Territorial Operations**

Operators of aircraft flying between the 50 States of the United States and foreign points, between the 50 States and U.S. possessions or territories, and between foreign points. Includes both the combination passenger/cargo carriers and the all-cargo carriers engaged in international and territorial operations.

**Intrastate Air Carrier**

A carrier licensed by a state to operate wholly within its borders but not permitted to carry interline passengers from out of state. They are not regulated by the CAB.

**Military**

Activities under charter or other contract with the Department of Defense.

**Other Use**

Use of general aviation aircraft for purposes other than those in specific categories, such as business, personal, air taxi.

**Personal and Pleasure Flying**

Any use of an aircraft for personal purposes not associated with a business or profession, and not for hire. This includes maintenance of pilot proficiency.

**Regional Carrier**

Certificated domestic route air carriers operating routes of lesser density between the smaller traffic centers and between those centers and principal centers.

**Public Aircraft**

Aircraft used only in the service of a government or a political subdivision.

**Supplemental Air Carrier**

One of a class of air carriers holding certificates, issued by the CAB, authorizing them to perform passenger and cargo charter service supplementing the scheduled service of the certificated route air carriers. They are often referred to as "nonskeds," i.e., nonscheduled carriers.

**U.S.-Flag Carrier or American-Flag Carrier**

One of a class of air carriers holding a certificate of public convenience and necessity issued by the CAB, approved by the President, authorizing scheduled operations over specified routes between the United States (and/or its territories) and one or more foreign countries.

**Figure VIII.2. Glossary of Selected Air Transportation Terminology.**

speed, payload, and comfort culminating in the wide-bodied jets (Boeing 747, DC-10, Lockheed L-1011) introduced in the 1970's. Many of these improvements resulted directly from research sponsored by the defense establishment for military applications. The most significant developments are listed in table VIII.2.

Air traffic has grown at the rate of almost 12 percent a year since 1945. The growth in terms of air passenger enplanements may be seen in figure VIII.3. Air carrier traffic grew very rapidly during the decade of the sixties with the introduction of jet aircraft, but present measures of domestic scheduled passenger traffic indicate that growth in the seventies has been slower. The Nation's scheduled air carrier revenue passenger enplanements in 1975 were over 205 million, and their revenue passenger-miles were 163 billion. The 1975 U.S. certificated route carrier fleet totaled 2,434 aircraft; the supplemental carriers, 106; and the commuter carriers, 1,073. By 1975, scheduled service was widely available at airports throughout the United States and its possessions (see fig. VIII.4).

**Table VIII.2**
**Technology Improvements In Civil Transportation Aircraft**

| Aircraft Type | Year | Improvement |
|---|---|---|
| Ford Tri-Motor | 1926 | All Metal Construction, Multi-Engine Reliability |
| Boeing 247;DC-2;DC-3 | 1933-36 | Longer Range; Higher Speed and Payload: 14ST Aluminum |
| DC-4 | 1945 | Higher Speed and Payload; Overwater Operations; Longer Range; Four-Engine Reliability; 24 ST Aluminum |
| Constellation: DC-6 | 1946-47 | Higher Speed; Payload; Pressurization; Longer Range; Higher Cruise Altitude |
| Super Constellation; DC-7; DC-7C | 1953-56 | Higher Speed; Payload and Range; Transcontinental Flight Time Under 8 Hours; 75 ST Aluminum |
| Viscount; Electra | 1955-59 | Turboprop, Less Vibration and Noise; Higher Speed |
| B-707; DC-8 | 1958-59 | Jet Power; Speed; Better Passenger Comfort; 7178 ST Aluminum |
| B-727; B-737; DC-9 | 1964-68 | Shorter Haul; Local Service |
| B-747 | 1970 | Wide-Body Capacity; High Bypass Ratio Engines |
| Concorde | 1976 | Speed |

*Source: DOT/NASA-CARD Study, March 1971.*

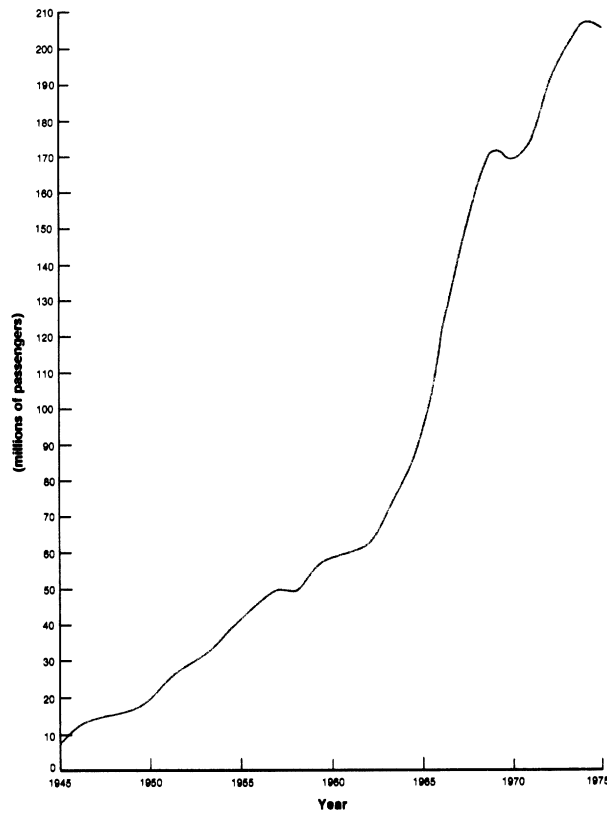



**Figure VIII.3. 1945-1975 Revenue Passenger Enplanements.**

General aviation activity has experienced a similar pattern, and by 1975, hours flown reached 32.2 million and the general aviation fleet totaled 161,550 aircraft.

In 1975, there were 23,748 military aircraft and 3,036 public aircraft (excluding Coast Guard) also in service.

## ELEMENTS OF THE AIR SYSTEM

The Nation's aviation system can be described in terms of the physical network (airports, airways, and related services), the aircraft, the skilled personnel, and the supporting systems, in particular the air traffic control system.

### Airports

There are 13,251 airports today in the United States. About 600 of these are regularly served by CAB-certificated carriers; the rest primarily serve general aviation. The total investment in U.S. airports to date is $10 billion. Almost half of this has been invested by the Federal Government under a number of programs. These are listed as follows:

| | Billion |
|---|---|
| 1930's depression relief program | $0.4 |
| World War II defense programs | 0.4 |
| Postwar surplus property program | 1.6 |
| Federal-aid airport program (FAAP) | 1.2 |
| Airport development aid program (ADAP) | 1.3 |
| Total | $4.9 |

Airports are designated on the detailed maps of the appendix. Annual aircraft operations at airports with FAA control towers are shown for 1975 and 1990 in the two maps located in the envelope in the back of the book.

### Aircraft

Great variety of purpose and capability characterizes the almost 200,000 aircraft that use the Nation's airways. The many shapes, sizes, and performance traits of craft that constitute the commercial fleet may be seen in figure VIII.5. In addition to this, great variety exists in general aviation aircraft and military aircraft.

### Air Traffic Control and Navigational Aids

Air traffic control (ATC) services and navigational aids (NAV) promote the safe, orderly, and expeditious flow of aircraft on the ground and in the airspace of the United States and its territories. Details on the major elements of each system appear in figure VIII.6.

## TRANSITIONAL ISSUES

The growth of aviation worldwide has been little short of phenomenal. That we have been able to develop, operate, and use, during rapid change, a system as responsive, complex, and safe as our Nation's airways is a tribute to American technology and management skills. Nevertheless, the system is not without problems, and there are a number of issues to be resolved that will impact the form of future operations.

The following sections develop more detailed information on these issues, and the options available to our officials and decisionmakers that will alter the system's influence on and response to 1990 travel demand. The two most controversial of these, cost recovery and regulatory reform, will be treated first. Problems concerning urban and rural access will be treated next. Finally, some of the problems dealing with operations, such as congestion, airline security, and noise pollution will be considered. The effect of all these factors is reflected in the description of the future aviation system in the section with that title later in this chapter.

### Cost Recovery

***Background.*** In its early stages, Government subsidies in the form of mail rates were instrumental in fostering development of our air transportation system. Through the years, other forms of Government support appeared, particularly the development of a highly sophisticated air traffic control system and navigational aids. In recent years, however, the air carriers have been, for the most part, paying for their share of the airport and airways costs through ticket and waybill taxes. By the mid-1950's, the mail rate subsidy had been largely eliminated.

Today, two major subsidies remain: those provided to privately owned regional air carriers to insure scheduled airline service to small communities, and the costs of the airport and airways system allocable to general aviation of which users pay only part. The first is discussed in a section that follows, "Service to Small Communities." The second has been the subject of much controversy, as to both the costs allocable to each of the major using groups, and the time when full cost recovery will be achieved.

The Airport and Airway Development and Revenue Act of 1970 directed the Secretary of Transportation to (a) determine the costs of the Federal Airport and Airway System, (b) determine how these costs should be allocated among various users, and (c) recommend equitable ways of recovering these costs.

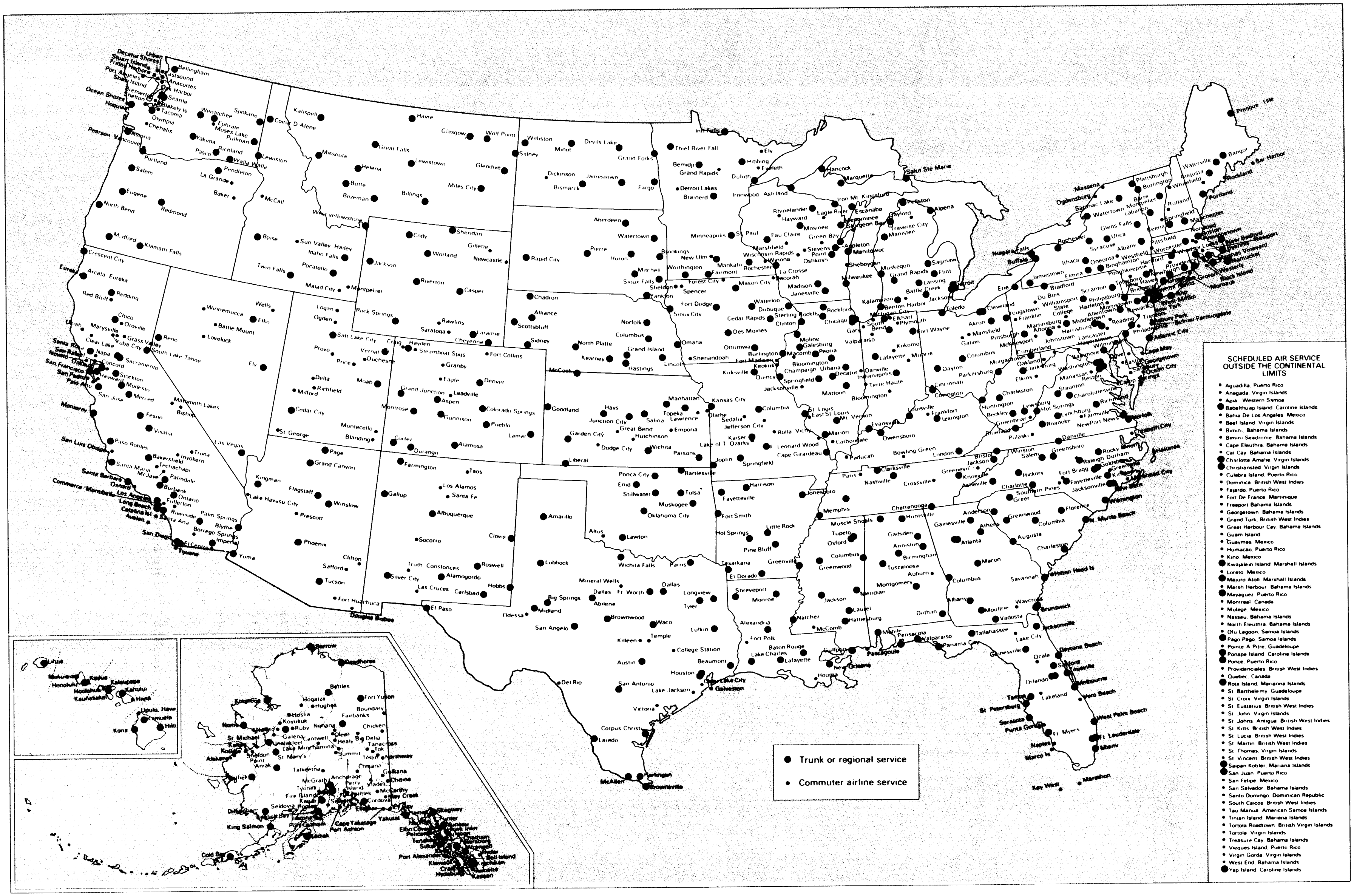
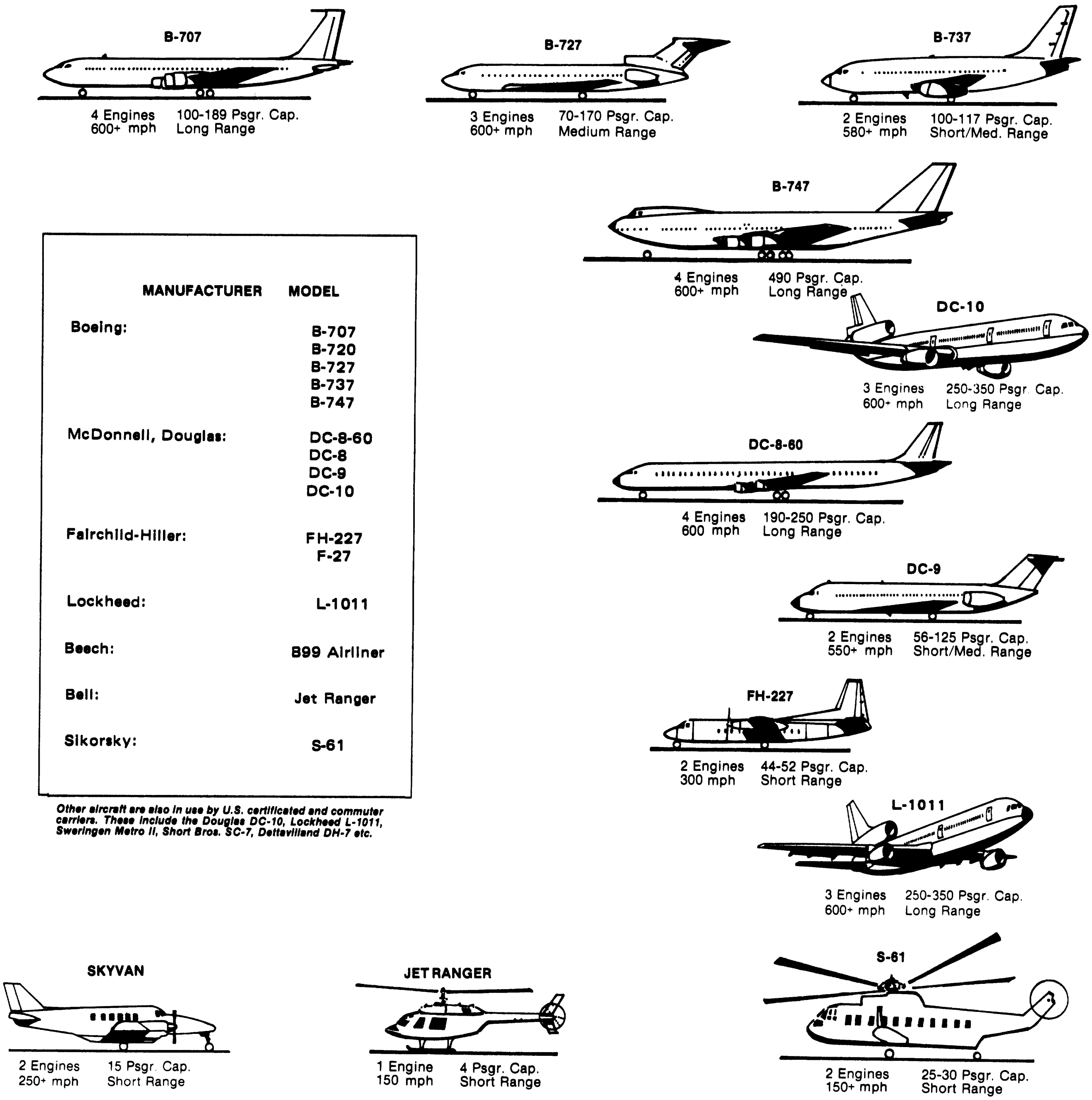



**FIGURE VIII.4 AIRPORTS WITH SCHEDULED SERVICE.**
(Trunk, Regional and Commuter)




| MANUFACTURER | MODEL |
|---|---|
| Boeing: | B-707<br>B-720<br>B-727<br>B-737<br>B-747 |
| McDonnell, Douglas: | DC-8-60<br>DC-8<br>DC-9<br>DC-10 |
| Fairchild-Hiller: | FH-227<br>F-27 |
| Lockheed: | L-1011 |
| Beech: | B99 Airliner |
| Bell: | Jet Ranger |
| Sikorsky: | S-61 |

***Other aircraft are also in use by U.S. certificated and commuter carriers. These include the Douglas DC-10, Lockheed L-1011, Swearingen Metro II, Short Bros. SC-7, Dettavilland DH-7 etc.***

Aircraft speeds shown are maximum cruising speeds as specified by manufacturers.

**Figure VIII.5. Examples of Aircraft in Commercial Use.**

**Air Traffic Control**

En Route

- 26 air route traffic control centers (ARTCCs), 20 of which are computer equipped (NAS Stage A, Model A3d2)
- 95 air route surveillance radars (ARSR)
- 97 air traffic control radar beacon systems (ATCRBS)

Terminal

- 401 airport traffic control towers (ATCT)
- 61 automated radar terminal system, series III (ARTS III)
- 150 airport surveillance radars (ASR)

Flight Service Stations

- 320 domestic and international flight service stations

**Navigational Aids**

En Route

- 900 VHF omniranges/tactical air navigation systems/distance measuring equipment (VOR/VORTAC/VOR-DME)
- 296 nondirectional radio beacons (NDB)

Terminal

- 48 terminal VHF omniranges (TVOR)
- 535 VHF instrument landing systems (ILS)
- 54 partial ILS's

**Figure VIII.6. Elements of the Nation's Aviation System in 1975.**

In compliance with these directions, the Secretary prepared and submitted to Congress a report entitled "The Airport and Airway Cost Allocation Study" dated September 1973.

The major findings and conclusions of the report were:

- The costs of the Federal Airport and Airway System should be allocated as follows: 50 percent to air carriers, 30 percent to general aviation, and 20 percent to the public sector to support military and government flying. (See table VIII.3 for data supporting this basic recommendation.) The various functions and services that generate the costs appear in table VIII.4.
- The present tax structure recovers about 55 percent of total Federal costs from nonpublic users (compared with 80 percent that should be recovered).
- The largest shortfall in tax recovery is from the general aviation sector (that is, from private flying not classified as air carrier). Only 20 percent of the cost assigned to general aviation is being recovered through user taxes.

**Table VIII.3**
**Allocation of Airport and Airway Systems Costs**
(Millions of current dollars)

| Fiscal Year | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Air Carriers | | | | | | | | | | | |
| Allocated Costs[1] | 249.3 | 282.9 | 317.6 | 381.6 | 469.6 | 591.3 | 662.4 | 725.8 | 799.4 | 910.1 | 5,390.0 |
| Air Carrier Flights Treated as General Aviation[2] | 12.7 | 11.9 | 10.5 | 11.4 | 12.7 | 13.0 | 13.2 | 14.5 | 16.0 | 18.2 | 134.1 |
| Total Costs Allocated to Air Carriers | 262.0 | 294.8 | 328.1 | 393.0 | 482.3 | 604.3 | 675.6 | 740.3 | 815.4 | 928.3 | 5,524.1 |
| Percentage of Total Costs | 49.2% | 49.4% | 50.5% | 52.0% | 53.1% | 53.3% | 52.8% | 51.7% | 51.5% | 51.0% | 51.7% |
| General Aviation | | | | | | | | | | | |
| Allocated Costs[1] | 163.3 | 185.0 | 200.2 | 231.0 | 277.0 | 340.1 | 382.7 | 438.1 | 490.5 | 577.1 | 3,284.9 |
| Costs Attributable to Air Carriers[2] | -12.7 | -11.9 | -10.5 | -11.4 | -12.7 | -13.0 | -13.2 | -14.5 | -16.0 | -18.2 | -134.1 |
| Costs Attributable to Civil Government Aircraft[3] | -6.5 | -7.4 | -8.0 | -9.2 | -11.1 | -13.6 | -15.3 | -17.5 | -19.6 | -23.1 | -131.4 |
| Total Costs Allocated to General Aviation | 144.1 | 165.7 | 181.7 | 210.4 | 253.2 | 313.5 | 354.2 | 406.1 | 454.9 | 535.8 | 3,019.4 |
| Percentage of Total Costs | 27.1% | 27.8% | 28.0% | 27.8% | 27.9% | 27.6% | 27.7% | 28.3% | 28.7% | 29.4% | 28.2% |
| Public Share | | | | | | | | | | | |
| Cost Allocated to the Military[1] | 119.6 | 128.9 | 131.3 | 143.1 | 162.3 | 203.0 | 235.0 | 268.6 | 293.2 | 333.3 | 2,018.4 |
| General Aviation Costs Attributable to Civil Government Aircraft[3] | 6.5 | 7.4 | 8.0 | 9.2 | 11.1 | 13.6 | 15.3 | 17.5 | 19.6 | 23.1 | 131.4 |
| Total Costs Allocated to the Public | 126.1 | 136.3 | 139.3 | 152.3 | 173.4 | 216.6 | 250.3 | 286.1 | 312.8 | 356.4 | 2,149.8 |
| Percentage of Total Costs | 23.7% | 22.8% | 21.5% | 20.2% | 19.1% | 19.1% | 19.5% | 20.0% | 19.8% | 19.6% | 20.1% |
| Total Airport and Airway Costs | 532.1 | 596.9 | 649.1 | 755.6 | 909.0 | 1,134.5 | 1,280.0 | 1,432.5 | 1,583.1 | 1,820.4 | 10,693.3 |

[1] *These costs are allocated by the Long Run Marginal Cost Method. Two adjustments must be made to these sets of allocated costs. First, a number of air carriers nonrevenue flights are counted by the FAA as being general aviation flights. The allocations, which are based on FAA statistical measures of activity, must be adjusted to credit general aviation for those Federal costs actually incurred on behalf of air carriers. Second, civil government aircraft constitute one of the many diverse segments of* general aviation. The allocations must again be adjusted so that the cost of civil government aircraft use of the Airport and Airway System is properly attributed to the public share. [2] *Based on analysis of air carrier revenue and nonrevenue flying hours.* [3] *Estimated to be 4 percent of general aviation costs.*

*Source: U.S. Department of Transportation: "Airport and Airway Cost Allocation Study."* Part I, *Washington, D.C., September 1973.*

## Table VIII.4
## Airport and Airway Cost Base[1]
(Millions of current dollars for each fiscal year)

| Agency | | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Department of Transportation | | | | | | | | | | | | |
| Office of the Secretary | R&D | .1 | .1 | .3 | .7 | 1.3 | 2.0 | 2.8 | 3.3 | 3.4 | 3.4 | 17.4 |
| Federal Aviation Administration | R&D[2] | 4.1 | 8.7 | 13.3 | 18.0 | 23.5 | 32.4 | 42.7 | 50.2 | 60.7 | 71.3 | 325.0 |
| | F&E[3] | 11.0 | 22.8 | 37.9 | 58.9 | 79.6 | 121.7 | 176.8 | 231.8 | 284.5 | 336.8 | 1,361.8 |
| | R&M[4] | 17.5 | 39.0 | 36.0 | 32.5 | 32.5 | 43.1 | 54.1 | 89.3 | 61.3 | 68.9 | 474.4 |
| | O&M[5] | 481.0 | 508.0 | 546.0 | 627.0 | 752.0 | 914.0 | 938.0 | 1,037.0 | 1,152.0 | 1,318.0 | 8,318.0 |
| Total | | 513.6 | 578.5 | 633.2 | 736.4 | 887.6 | 1,111.2 | 1,256.6 | 1,408.3 | 1,558.6 | 1,795.0 | 10,479.2 |
| Department of State | O&M[5] | 1.2 | 1.7 | 1.4 | 1.4 | 1.7 | 1.8 | 2.2 | 2.1 | 2.2 | 2.4 | 18.0 |
| National Oceanic and Atmospheric Administration | R&D[2] | .1 | .1 | .2 | .2 | .3 | .4 | .5 | .6 | .7 | .8 | 3.8 |
| | F&E[3] | .0 | .2 | .3 | .3 | .5 | .5 | .6 | .7 | .7 | .7 | 4.5 |
| | O&M[5] | 17.2 | 16.4 | 13.7 | 16.6 | 17.6 | 18.5 | 17.3 | 17.6 | 17.5 | 18.1 | 170.4 |
| Total | | 17.3 | 16.7 | 14.2 | 17.1 | 18.4 | 19.4 | 18.4 | 18.8 | 18.9 | 19.6 | 178.7 |
| Total | | 532.1 | 596.9 | 649.1 | 755.6 | 909.0 | 1,134.5 | 1,280.0 | 1,432.5 | 1,583.1 | 1,820.4 | 10,693.3 |

[1] *This cost base is presented here in terms of "Format II": Capital costs incurred prior to 1966 are treated as "sunk" and are excluded. Capital expenditures made after 1964 are viewed as yielding a stream of benefits over time and are amortized.* [2] *Research and development.* [3] *Facilities and equipment.* [4] *Relocation and modification.* [5] *Operations and maintenance.*

*Source:* Airport and Airway Cost Allocation Study, Part 1. *Department of Transportation, Washington, D.C., September 1973.*

- The existing aviation tax structure is largely based on ticket and shipper excise taxes from air carriers and on fuel taxes for general aviation. This tax structure is only indirectly related to system costs and does not necessarily foster efficient use of the system.

The report recommended that the tax structure be shifted in the direction of increased user charges that more nearly reflect actual costs imposed by users upon the system and, consequently, provide stronger incentives for overall efficiency. These increased user charges should be phased in gradually to avoid disruptive effects on the industry.

The costs of running the future system, including the costs of upgrading the air traffic control system, are provided in the *National Aviation System Plan* for fiscal years 1977 through 1986. Table VIII.5, drawn from that plan, indicates that a total of $7.13 billion will be needed to upgrade the national aviation system during the 1977–86 period. This includes $2.48 billion to be spent for new facilities and equipment, and the replacement, relocation, and improvement of some existing facilities and equipment.

During the 1977–86 period, a total of $6.6 billion is proposed for grants-in-aid for airports. Other resources required for upgrading the air traffic control system during the 1977–86 period include $807 million for research and engineering and $173.8 million for construction at national capital airports.

The projected Aviation Trust Fund activity for the period FY 1977–80 is found in table VIII.6. Those funds will be augmented by taxpayers through the General Fund. A summary of the total resources available by type of appropriation appears in table VIII.7. Of the total of $30.9 billion, $9.92 billion (32.1 percent) represents anticipated expenditures from the Trust Fund and $20.97 billion (67.9 percent) represents expenditures from the General Fund. It should be noted that although the predominant portion is paid for by the taxpayers, expenditures for capital improvement projects (research, engineering, and development; facilities and equipment; and grants-in-aid for airports) for the most part will be appropriated from the Trust Fund. The Airport and Airway Development Act Amendments of 1976 now authorize the use of airport grant-in-aid

**Table VIII.5**
**Upgrading of Air Traffic Control System**
(Millions of 1975 dollars)

| Type of Facility | 1977 | 1978 | 1979 | 1980 | 1981 | 1977-81 | 1982-86 | 1977-86 |
|---|---|---|---|---|---|---|---|---|
| En Route Control Facilities F and E Program Plan | 47.2 | 55.0 | 33.5 | 37.0 | 36.0 | 208.7 | 245.0 | 453.7 |
| Terminal Control Facilities F and E Program Plan | 49.3 | 76.0 | 74.0 | 74.0 | 67.0 | 340.3 | 402.0 | 742.3 |
| Flight Service Facilities F and E Program Plan | 48.2 | 42.5 | 45.2 | 59.5 | 60.7 | 256.1 | 161 0 | 417.1 |
| En Route Navigation Aids F and E Program Plan | 14.5 | 16.0 | 26.5 | 16.0 | 22.5 | 95.5 | 100.0 | 195.5 |
| Landing Aids F and E Program Plan | 35.8 | 34.0 | 48.4 | 46.9 | 44.1 | 209.2 | 212.0 | 421.2 |
| System Support Program Plan | 31.6 | 26.5 | 22.4 | 16.6 | 19.7 | 116.8 | 130.0 | 246.8 |
| Total F and E Program Plan | 226.6 | 250.0 | 250.0 | 250.0 | 250.0 | 1,226.6 | 1,250.0 | 2,476.6 |
| Research and Engineering | 76.7 | 75.0 | 75.0 | 75.0 | 75.0 | 367.7 | 430.5 | 807.2 |
| Grant-in-Aid for Airports[1] | 525.0 | 555.0 | 590.0 | 625.0 | 645.0 | 2,940.0 | 3,700.0 | 6,640.0 |
| Construction, National Capital Airports | 8.1 | 6.3 | 22.4 | 25.0 | 22.0 | 84.8 | 90.0 | 173.8 |
| Total Resource | 836.4 | 886.3 | 937.4 | 975.0 | 992.0 | 4,628.1 | 5,470.5 | 10,097.6 |

[1]*Updated to reflect funding levels for FY 1977-80 authorized under the Airport and Airway Development Act Amendments of 1976 (P.L. 94-353).*
*Source:* The National Aviation System Plan—Fiscal Years 1977-1986, *Federal Aviation Administration.*

**Table VIII.6**
**Projected Aviation Trust Fund Activity: FY 1977-1980**
(Thousands of 1975 dollars)

| Fiscal Year | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|
| Beginning Uncommitted Balance | 1,188 | 1,275 | 1,434 | 1,671 |
| Trust Fund Revenues | 1,054 | 1,121 | 1,154 | 1,217 |
| Subtotal | 2,242 | 2,396 | 2,588 | 2,888 |
| Less: Development Expenditures | 350 | 350 | 350 | 350 |
| F and E Expenditures | 250 | 250 | 250 | 250 |
| O and M Expenditures | 476 | 470 | 489 | 509 |
| Other Expenditures | 77 | 100 | 98 | 94 |
| Subtotal | 1,153 | 1,170 | 1,187 | 1,203 |
| Difference | 1,089 | 1,226 | 1,401 | 1,685 |
| Interest on previous year's balance | 186 | 208 | 220 | 236 |
| Ending Uncommitted Balance | 1,275 | 1,434 | 1,621 | 1,921 |

*Source: National Aviation System Plan*

funds for terminal development (including multimodal terminal development) in nonrevenue-producing, public-use areas that are directly related to movement of passengers and baggage. Additionally, the Act also provides that certain facilities' maintenance costs can now be supported from the Trust Fund at an annual average amount of $287.5 million through FY 1980.

**Table VIII.7**
**Estimated Resource Availability Summary**
(Millions of 1975 dollars)

| Appropriation | Planned | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | 1977 | 1978 | 1979 | 1980 | 1981 | 1982-86 | 1977-86 |
| Trust Funds: | | | | | | | |
| Research, Engineering, and Development | 76.7 | 75.0 | 75.0 | 75.0 | 75.0 | 430.5 | 807.2 |
| Facilities and Equipment | 226.6 | 250.0 | 250.0 | 250.0 | 250.0 | 1,250.0 | 2.476.6 |
| Grant-in-aid for Airports[1] | 525.0 | 555.0 | 590.0 | 625.0 | 645.0 | 3,700.0 | 6,640.0 |
| General Fund: | | | | | | | |
| Operations | 1,677.5 | 1,855.8 | 1,936.7 | 2,010.5 | 2,086.9 | 10,850.0 | 20,417.4 |
| Facilities, Engineering, and Development | 14.6 | 18.3 | 18.3 | 17.5 | 16.8 | 84.2 | 169.7 |
| Operations and Maintenance, National Capital Airports | 20.7 | 21.1 | 21.5 | 21.5 | 21.7 | 110.0 | 216.5 |
| Construction, National Capital Airports | 8.1 | 6.3 | 22.4 | 25.0 | 22.0 | 90.0 | 173.8 |
| Total | 2,549.2 | 2,781.5 | 2,913.9 | 3,024.5 | 3,117.4 | 16,514.7 | 30.901.2 |

[1]*Updated to reflect funding levels for FY 1977-80 authorized under the Airport and Airway Development Act Amendments of 1976 (P.L. 94-353).*
*Source: National Aviation System Plan*

***Cost Recovery Alternatives.*** General aviation utilizes many of the airport and airway services provided by the Federal Government. As indicated earlier, reimbursement received from general aviation through user charges presently covers only a portion of the costs of services provided to this segment of the aviation community. To promote efficient allocation of national resources in the future, the level of cost recovery from general aviation should be increased commensurate with the costs imposed by this group on the national airport and airway system.

A phased increase in user charges to general aviation is proposed as a remedy. The choice of the collection mechanism warrants additional study. The costs allocable to some segments of general aviation are relatively small. A study on how best to impose general aviation user charges is now underway and should be completed in early 1977. After enactment of the necessary legislation, user charges would be implemented in steps. The impact of each step would be assessed before moving on to the next phase.

It is, therefore, of interest in long-range planning to consider the 1990 impacts of alternative schedules of both direct and indirect user charges. For that purpose, five user-charge schedules have been analyzed in terms of how they would affect flying hours, operations, aircraft handled at en route centers, and use of flight services. Note that under all the cost recovery alternatives, general aviation activity would increase substantially between 1975 and 1990.

The following five general aviation user-charge schedules were considered:

- *Alternative 1* — Continuation of the present 7-cent fuel tax to 1990 (which may be considered as the baseline case). Under this alternative, total general aviation operations would grow at a rate of 4.6 percent annually.
- *Alternative 2* — Adoption of a 15-cent fuel tax (less than half recovery). The growth rate in total general aviation operations would be 4.2 percent annually.
- *Alternative 3* — Adoption of fuel tax sufficient to recover costs of GA-only airport development, GA-only airport terminal control, and flight service stations. In this case, total general aviation operations would grow at a rate of 3.9 percent annually.
- *Alternative 4* — Adoption of a combination of fuel taxes and direct charges (landing fees) to recover costs of GA-only airport development, GA-only airport terminal control, and flight service stations. Total general aviation operations would increase 4.3 percent annually.
- *Alternative 5* — Adoption of a combination of fuel taxes and direct charges sufficient to recover all costs allocated to general aviation by the *Cost Allocation Study*. As recommended by the *Cost Allocation Study*, the annual airport and airway system cost base amortizes capital expenses over the expected life of the investment. Under this alternative, total general aviation operations would increase 3.3 percent annually.

The results of the analysis for the entire system, including airports, which do not receive Federal assistance, are summarized in table VIII.8. They indicate the following:

- *Flying hours* — Under all alternatives, the increased cost of flying is expected to reduce the number of hours flown from the base case (alternative 1) level. Decreases by 1990 range from 6 percent for the fuel tax plus landing fees proposal (alternative 4) to 18 percent for full cost recovery under a combination of fuel taxes and direct charges. The alternatives that use direct charges as a principal cost recovery vehicle have less adverse effects on flying hours than attempts to recover similar amounts of revenue by means of a fuel tax. This phenomenon is caused by the assumed diversion of many general aviation operations (probably local and training flights) from federally funded facilities to airports that receive no Federal funds and where, consequently, there are no Federal direct charges.
- *Itinerant operations* — Changes in systemwide itinerant operations (numbers of takeoffs and landings) tend to be more severe than changes in hours flown. The 1990 impacts range from an 8-percent reduction in itinerant operations under the 15-cent fuel tax proposal to a 41-percent decrease under full cost recovery through a combination of fuel taxes and direct charges. Interestingly, cost recovery by means of fuel taxes (alternative 3) may produce higher cutbacks in total system operations than

**Table VIII.8**
**Systemwide Impact of Alternative Schedules of User Charges on General Aviation Activity [1]**

| Type of Activity | Alt. 1[2] | Alt. 2 | Alt.3 (Millions) | Alt. 4 | Alt. 5 | Percent Change From Alt 1: Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 |
|---|---|---|---|---|---|---|---|---|---|
| Itinerant Operations | | | | | | | | | |
| 1975[3] | 60.5 | 60.5 | 60.5 | 60.5 | 60.5 | – | – | – | – |
| 1980 | 70.3 | 63.4 | 63.4 | 65.2 | 60.8 | -9.8 | -9.8 | -7.2 | -13.5 |
| 1985 | 88.6 | 80.5 | 75.4 | 77.9 | 62.0 | -9.1 | -14.9 | -12.1 | -30.0 |
| 1990 | 111.6 | 102.7 | 96.3 | 99.1 | 65.9 | -8.0 | -13.7 | -11.2 | -40.9 |
| Local Operations | | | | | | | | | |
| 1975[3] | 70.2 | 70.2 | 70.2 | 70.2 | 70.2 | – | – | – | – |
| 1980 | 87.3 | 80.1 | 80.1 | 88.2 | 88.3 | -8.2 | -8.2 | 1.0 | 1.1 |
| 1985 | 111.8 | 106.0 | 102.3 | 112.0 | 112.1 | -5.1 | -8.5 | .2 | .3 |
| 1990 | 145.9 | 139.6 | 135.0 | 145.6 | 145.5 | -4.3 | -7.5 | -.2 | -.3 |
| Total Operations | | | | | | | | | |
| 1975[3] | 130.7 | 130.7 | 130.7 | 130.7 | 130.7 | – | – | – | – |
| 1980 | 157.6 | 143.5 | 143.5 | 153.4 | 149.1 | -8.9 | -8.9 | -2.7 | -5.4 |
| 1985 | 200.5 | 186.5 | 177.7 | 189.9 | 174.1 | -7.0 | -11.4 | -5.3 | -13.2 |
| 1990 | 257.5 | 242.3 | 231.3 | 244.7 | 211.4 | -5.9 | -10.2 | -5.0 | -17.9 |
| Aircraft Handled | | | | | | | | | |
| 1975[3] | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | – | – | – | – |
| 1980 | 7.9 | 7.5 | 7.5 | 7.5 | 7.2 | -5.0 | -5.0 | -5.0 | -8.9 |
| 1985 | 11.5 | 10.8 | 10.4 | 10.4 | 9.3 | -6.0 | -9.6 | -9.6 | -19.1 |
| 1990 | 16.5 | 15.4 | 14.8 | 14.8 | 11.9 | -6.7 | -10.3 | -10.3 | -27.9 |
| Flight Services | | | | | | | | | |
| 1975[3] | 58.3 | 58.3 | 58.3 | 58.3 | 58.3 | – | – | – | – |
| 1980 | 89.9 | 86.6 | 86.1 | 86.1 | 83.5 | -3.7 | -4.2 | -4.2 | -7.1 |
| 1985 | 124.8 | 118.9 | 116.0 | 116.0 | 105.2 | -4.7 | -7.1 | -7.1 | -15.7 |
| 1990 | 172.0 | 164.6 | 162.5 | 162.5 | 132.2 | -4.3 | -5.5 | -5.5 | -23.1 |
| Hours Flown | | | | | | | | | |
| 1975[3] | 32.2 | 32.2 | 32.2 | 32.2 | 32.2 | – | – | – | – |
| 1980 | 41.5 | 37.6 | 37.6 | 40.2 | 39.2 | -9.4 | -9.4 | -3.1 | -5.5 |
| 1985 | 54.0 | 50.6 | 47.8 | 50.9 | 46.8 | -6.3 | -11.5 | -5.7 | -13.3 |
| 1990 | 70.7 | 65.8 | 63.3 | 68.8 | 58.1 | -6.9 | -10.0 | -5.5 | -17.8 |

*[1]Includes all general aviation activities—at all facilities; FAA towered, non-towered, and other. Excludes unscheduled airtaxis.*
*[2]Alternative 1 (Alt. 1) represents baseline data under current changes. Other alternatives represent different assumptions about user charges.*
*[3]Aircraft Handled and Flight Service data for 1975 are based on actual historical data. All other data are estimates.*

charging direct fees at airports receiving Federal assistance coupled with a lower fuel tax (alternative 4). This phenomenon is the net result of both different cost sensitivities of operations at federally assisted versus nonassisted airports and different levels of total tax on these operations. The higher reduction in operations at federally assisted airports is more than offset by the lower reduction in operations at nonassisted airports.

• *Local operations* — The 1990 systemwide effects of increased user charges on local operations range from a less-than-1-percent decrease for cost recovery programs relying primarily on direct charges at airports receiving Federal assistance to a 7.5-percent reduction consistent with partial recovery schemes based solely on fuel taxes. The explanation is that under direct charges most local operations would choose to divert to airfields where Federal fees would not be charged. By diverting, local flights could avoid the added cost of user charges. Cost recovery by means of fuel taxes, however, could not be avoided by diversion, and local operations would, therefore, experience reductions as a result of the increased flying costs.

• *Total operations* — Systemwide impacts of user charges on total operations are the combined effect of charges on systemwide itinerant and local operations. The 1990 reductions associated with increased cost recovery range from 5 percent for alternative 4 to 18 percent for full cost recovery by means of a combination of direct charges and fuel taxes (alternative 5).

• *Aircraft handled at en route centers* — Impacts of increased cost recovery on Instrument Flight Rule (IFR) service to general aviation by en route centers parallel the impacts on general aviation flying in general, but at a slightly lower reduction rate. The types of aircraft that use IFR service are less sensitive to increased costs than the average general aviation aircraft. The 1990 reductions range from a low of 7 percent for the fuel tax to 28 percent for full cost recovery by means of combined direct charges and fuel taxes.

• *Flight services* — Of all the systemwide activities, general aviation use of flight services is projected to experience the smallest reductions associated with increased cost recovery under the alternatives investigated. Impacts range from 4 to 23 percent depending on the level and type of changes considered.

In summary, it was found that attempts at full cost recovery will have substantial impacts on systemwide general aviation activity regardless of whether direct or indirect charges are used to accomplish recovery. In general, direct charge schemes have less overall impact on general aviation activity than indirect methods such as fuel taxes. On the other hand, direct charges reduce use of FAA airport and airway system facilities more than fuel taxes. The use of these FAA facilities has historically been encouraged to improve the general level of aviation safety. Reliance on direct charges alone might increase the possibility of accidents and lead to more safety-related problems at non-FAA facilities.

**Regulatory Reform**

In the U.S. air carrier market, as with trucks and railroads, outmoded regulation has inhibited the ability of the marketplace to act as the ultimate arbiter among efficiency, price, and consumer preference. Today's system of economic regulation over U.S. domestic airlines was established by the Civil Aeronautics Act of 1938. The Civil Aeronautics Board (CAB) was created at that time because there was a belief that some form of government intervention was necessary to protect the infant airline industry. In the manner of traditional public utility regulation, this regulation includes control over prices, entry into markets, and abandonment of service, but in the policy statement of the Act, the Board was also charged with promoting the industry's growth and development. Entry into the industry was strictly controlled. Airlines permitted to enter were vigorously controlled as to markets they could serve. Regulation permitted little in terms of managerial freedom. Fares were regulated. Real competition was intentionally dampened.

As a result, the Administration, members of Congress, and the Civil Aeronautics Board have submitted aviation regulatory reform bills to Congress that would make major reforms in the economic regulatory system applying to airlines. In addition, several other minor aviation regulatory reform bills have been prepared and are pending before the Congress. The major areas addressed by the Administration proposal are pricing, entry into air carriage, abandonment of service, anticompetitive agreements, subsidies, and mergers. The proposed Administration Act is directed toward a gradual relaxation of many current constraints that would result in a more flexible and efficient airline industry offering better service. It would charge the Civil Aeronautics Board to develop a system with a prime purpose of satisfying public needs rather than industry needs, to place maximum reliance on competitive market forces, and to encourage entry of new carriers—at the same time preserving the highest degree of safety.

***Ticket Pricing.*** In aviation, price competition between carriers has been discouraged by Federal regulation. It is now believed that regulatory restrictions on price competition have produced air fares that are higher than they should be. For example, while carriers in intrastate markets are subject to Federal safety regulations, they are free from Federal economic restrictions on fares and routes. In these markets, such as in Texas and California, prices have been lower than in comparable interstate markets. Scheduled commuter air carriers, operating equipment that is more costly per passenger-mile, charge comparable or lower fares than regulated carriers for similar distances.

Air carriers have not earned unusually high profits from this lack of price competition. Reasonable profits that might have been earned have been dissipated through service competition, including scheduling additional flights with excess capacity.

All of the proposed Acts substantially increase pricing flexibility. Airlines may lower fares without approval so long as there is no predatory pricing or undue preference. Under the Administration's Bill, fare decreases may be disallowed only if they are below the direct cost of the service in question. Fares may be increased by an established percentage per year without CAB involvement.

The new ticket-price competition, with the threat of new competitors in the industry, will prevent fares from simply going up. If an airline tries to raise its fares too high, one or more of its competitors will be able to charge a lower fare and take the traffic. If costs rise, then fares probably will rise. This is true under the current regulatory system and it will be true under the proposed system. But, average fares probably would be lower under the new system than what they otherwise would be under the present system.

***Entry.*** The CAB controls the entry of new firms into the aviation sector, as well as the expansion of existing firms into additional markets. With minor exceptions, no new scheduled passenger carriers have been licensed since 1950. No new carrier has been permitted to enter major airline service since 1938. The effect of this restriction on entry has been to deny consumers the benefits of services that efficient and innovative carriers have been willing to provide.

Numerous conditions and restrictions have been attached to the operating certificate held by air carriers. For example, some flights may not carry local passengers. Others may not provide through service or must continue to points beyond their logical destination. These restrictions protect the markets of established air carriers and add to costs by wasting aircraft, fuel, and labor.

The proposed aviation Acts would also change these outdated conditions. They would reduce substantially the barriers facing qualified firms that wish to enter into air transportation, expand into new markets, or offer innovative service. In addition, they provide for increased entry while giving the airlines time to rationalize their options and adjust to the changing regulatory environment.

The two examples of pricing and entry indicate the manner by which passengers in major markets are expected to benefit and new services are likely to be developed once regulatory controls are relaxed. Among the most likely new services that are not now offered to airline passengers would be the institution of no-frill, high-density seating, and low-priced service in long-haul, predominantly pleasure markets. Equally likely seems the development of low-priced, high-load-factor services utilizing large-capacity aircraft in dense and medium short-haul markets similar to those developed in the California and Texas intrastate markets. Also likely would be the development of super first-class services in markets where the demand would support such service. This service might be expected to have low load factors, with more amenities and comfort than are available in today's first-class service. The market for this service would be travelers of today's executive jets as well as a portion of the current first-class market.

## Access to the Aviation System

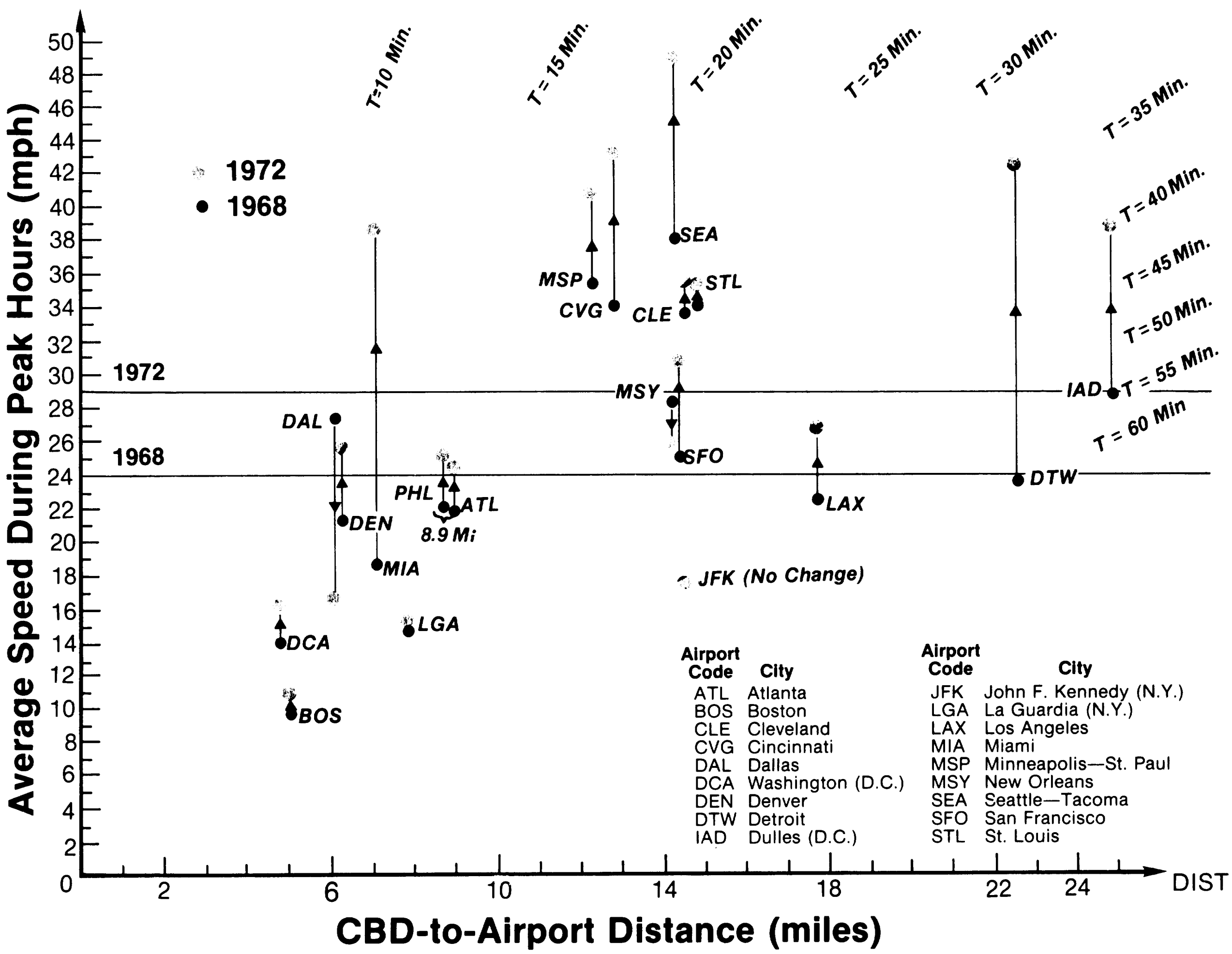
For many trips, especially those of shorter length, the speed and convenience of air service is frequently offset by the difficulties of gaining access to the system.

A major improvement in connectivity would be provided by an integrated ticketing, limousine, and baggage-handling service. With a single telephone call to one source, an individual could arrange for all trip components to be door to door. Such a system is within the current state-of-the-art in terms of technology, and should cost less than the present system.

The access problem affects those who live in highly populated urban areas, those who live in small communities, and those who live in rural areas. Problems of access in large urban areas deal with transportation to and from the airport. The access problem for many small communities involves service into and out of the airport serving that community, both for basic transportation needs and as a linkage to trunkline service. The problem for rural areas is one of facilitating their ability to include air service as part of a coordinated transportation system to meet the needs of their citizens. These problems will be discussed in turn.

***Urban Area Access.*** The vast majority of air trips are multimodal, in that air passengers arrive at the airport to begin their trip and leave the airport of destination via some other mode: the automobile, the mass transit system, intercity bus, limousine, or taxi. Therefore, commercial air and urban transportation services are complementary, in that the costs, the convenience, the reliability, and other characteristics of the urban transport system are likely to affect the demand for commercial air travel, and vice versa. There has been continuing interest in the extent to which limited landside capacity constricts an airport's ability to use its available airside capacity. Currently, 15 of the top 20 airports, representing 56 percent of total enplanements at all airports, are congested at the airport/urban interface. This congestion is often airport specific and occurs more frequently on highways immediately adjacent to and inside the airport boundary. Two detailed surveys of highway access to airports conducted by the Federal Highway Administration (FHWA) in 1968 and 1970 found that average traveltimes from central business districts to the airport boundaries have been decreasing. The survey results are shown graphically in figure VIII.7.

The driving times from the central business districts to the airports are of special interest since over 95 percent of airport trips are made with rubber-tired vehicles. Typically, the private automobile accounts for 70 percent of total passenger arrivals, and buses, limousines, and taxis account for approximately another 25 percent. Practically all major airports are served by a freeway or an expressway, and many of these facilities have either recently been improved or are presently undergoing




| Airport Code | City |
|---|---|
| ATL | Atlanta |
| BOS | Boston |
| CLE | Cleveland |
| CVG | Cincinnati |
| DAL | Dallas |
| DCA | Washington (D.C.) |
| DEN | Denver |
| DTW | Detroit |
| IAD | Dulles (D.C.) |
| JFK | John F. Kennedy (N.Y.) |
| LGA | La Guardia (N.Y.) |
| LAX | Los Angeles |
| MIA | Miami |
| MSP | Minneapolis—St. Paul |
| MSY | New Orleans |
| SEA | Seattle—Tacoma |
| SFO | San Francisco |
| STL | St. Louis |

**Figure VIII.7. Average Highway Speeds From Central Business District to Airports.**

improvements. Therefore, some additional time reductions can be expected in the highway portion of the airport trip in the future.

The FHWA survey trips were intentionally terminated at the airport boundary, since the purpose of the survey was to obtain data for the off-airport segment of the trip. For most major airports, severe congestion problems during peak periods occur on the internal circulation system within the airport boundaries (access/egress roads and parking facilities). Thus it is within the airport boundary that improvements to roadways and traffic circulation patterns offer the greatest potential for congestion reduction and improved airport access.

***Service to Small Communities.*** Aviation contributes directly to meeting rural transportation needs. Investment in airports has proved to be a significant factor in the development of certain types of rural and small urban area economic activity. Similarly, there are certain types of economic activity and recreation for which air access is a prerequisite. In addition, there are benefits such as linkage to the intercity air transportation system and special emergency services that are both important and dependent on air access. In many rural areas, considerable local transportation is performed through general aviation.

Public air transportation to rural areas is provided by regional (local service) carriers, scheduled commuter airlines, and on-call air taxis. In addition, the CAB has been subsidizing some regional carriers to maintain service into certain subsidy-eligible points. In 1974, that subsidy totaled $74 million.

This subsidy has become a point of issue. As regional carriers add larger jet aircraft to their fleets, they find it uneconomical to serve low-density, short-haul markets, and have in many cases received permission from the CAB to suspend service at those points. In some areas, scheduled commuter airlines offering frequent flights with small aircraft have moved in to fill the transportation gap. Not only do they maintain this service without subsidy, but in many cases they have been able to generate increased traffic because they offer more frequent service and have free access to all markets. One drawback is that nonpressurized aircraft without passenger amenities, which provide all that is essential for short-haul trips, do not always gain public acceptance.

The present system of subsidies for regional air carriers features a series of long-term, sole-source, cost-plus contracts. The contracts do not specify the service to be purchased in terms much more specific than "air transportation" in general. In essence, the Government reimburses regional air carriers for the costs incurred in running their systems, including a return on their investments. Because the subsidy payment calculation is based on average costs for all carriers, some regional carriers are paid a larger share of their disbursement than others.

There are many beneficiaries of this subsidy system, including airline stockholders, passengers on routes where jet service would not otherwise be provided, and passengers receiving nonstop service where such service would not ordinarily be provided. Nevertheless, the primary beneficiaries of this system are those who travel to points where air service would not otherwise be provided. The CAB has never attempted to estimate how much of the present subsidy is spent on providing service to marginal points, nor how much is spent on providing service to particular routes. It seems clear, however, that most of the money goes toward providing service on higher density routes and that very little goes to payments to carriers for serving marginal points.

If the total costs of the subsidy program are assigned to the primary beneficiaries and the primary beneficiaries are those passengers traveling to and from points that would face some risk of losing all scheduled service, the costs of the present subsidy program are over $200 per passenger, as may be seen from table VIII.9. If, instead, primary beneficiaries are only those passengers who travel to and from points where loss of service would be expected, the cost rises to over $500 per passenger.

**Table VIII.9**
**Cost of the Existing Subsidy Program**

| | |
|---|---|
| Number of points facing some risk of loss of all air service: 48 States | 50 |
| Total passengers enplaned | 100 |
| Total passengers to and from | 294,200 |
| Subsidy: FY 1974 | $66,666,306 |
| Subsidy per passenger [1] | $227 |
| Maximum number of points expected to lose all air service: 48 States | 29 |
| Total passengers enplaned | 64,600 |
| Total passengers to and from | 129,200 |
| Subsidy: FY 1974 | $66,666,306 |
| Subsidy per passenger [1] | $516 |

[1] *In addition to passenger service, subsidized points also receive freight and mail service.*

It seems clear that most present subsidy payments go toward providing service at locations other than marginal points. In order to examine alternatives to this subsidy program, it will be necessary to review how the pattern of service by certificated carriers and commuter carriers has changed.

*Changes in Service Patterns—Certificated Carriers.* The number of points served by trunk carriers has declined for 20 years. During this period, as shown in table VIII.10, trunk carriers have withdrawn from approximately half of the points they once served. The smaller points have been turned over to local service carriers, commuter carriers, or they have been abandoned. By 1976, trunk carriers served only two points in the 48 States that were entirely dependent upon the trunk airlines for scheduled air service and where fewer than 40 passengers per day were enplaned.[1]

[1] The points are Jamestown, N. Dak., and Merced, Calif. The passenger enplanement data are for 1974 and the availability of alternative service is based on the *Official Airline Guide, January* 1, 1976.

Most service to small communities by certificated carriers is now provided by local service carriers, which completed their expansion into smaller markets in the early 1960's. Only 16 airports in the continental 48 States now receive service by certificated carriers that did not receive such service in 1965. Of these 16 airports, 7 are satellite airports, a new regional airport, or associated with the certification of Air New England and Wright. Thus, only nine locations have been added to the network served by certificated carriers during the past 10 years.[2]

[2]Comparing the *Official Airline Guide* for December 1965 with that for August 15, 1975.

At the same time that new points were not being added to the system, smaller points were being dropped rapidly. The trend toward abandonment continues and is, if anything, increasing. As shown in table VIII.8, 39 points were dropped between the end of 1960 and the end of 1965. By 1971, 54 more points had been deleted, and by 1976, an additional 77.

Many factors are associated with the decline in the number of points served. The two most important have been the development of the Interstate Highway System and the transition to larger aircraft by certificated carriers.

**Table VIII.10**
**Points Served by Certificated Carriers in the 48 Contigous States**

| Year[1] | Trunk Carriers[2] | | | Regional Service Carriers[3] | | | All Carriers | | |
|---|---|---|---|---|---|---|---|---|---|
| | Points Authorized | Points Suspended | Points Served | Points Authorized | Points Suspended | Points Served | Points Authorized | Points Suspended | Points Served |
| 1955 | 376 | 27 | 349 | 381 | 18 | 363 | 583 | 44 | 539 |
| 1956 | 373 | 23 | 350 | 380 | 13 | 367 | 575 | 35 | 540 |
| 1957 | 368 | 25 | 343 | 387 | 9 | 378 | 579 | 33 | 546 |
| 1958 | 361 | 21 | 340 | 415 | 14 | 401 | 581 | 34 | 547 |
| 1959 | 332 | 23 | 309 | 468 | 29 | 439 | 610 | 52 | 558 |
| 1960 | 328 | 13 | 315 | 497 | 38 | 459 | 618 | 51 | 567 |
| 1961 | 309 | 13 | 296 | 494 | 28 | 466 | 601 | 39 | 562 |
| 1962 | 302 | 16 | 286 | 499 | 22 | 477 | 599 | 38 | 561 |
| 1963 | 251 | 11 | 240 | 475 | 11 | 464 | 562 | 22 | 540 |
| 1964 | 247 | 5 | 242 | 468 | 5 | 463 | 552 | 10 | 542 |
| 1965 | 231 | 4 | 227 | 472 | 4 | 468 | 536 | 8 | 528 |
| 1966 | 230 | 5 | 225 | 466 | 5 | 461 | 530 | 10 | 520 |
| 1967 | 229 | 7 | 222 | 467 | 7 | 460 | 526 | 14 | 512 |
| 1968 | 230 | 5 | 225 | 469 | 5 | 464 | 527 | 10 | 517 |
| 1969 | 228 | 4 | 224 | 470 | 4 | 466 | 526 | 8 | 518 |
| 1970 | 228 | 18 | 210 | 468 | 34 | 434 | 524 | 50 | 474 |
| 1971 | 228 | 18 | 210 | 467 | 34 | 433 | 523 | 52 | 471 |
| 1972 | 222 | 15 | 207 | 456 | 32 | 424 | 509 | 47 | 462 |
| 1973 | 221 | 19 | 202 | 446 | 40 | 406 | 498 | 56 | 442 |
| 1974 | 208 | 16 | 192 | 433 | 49 | 384 | 482 | 64 | 418 |
| 1975 | 198 | 18 | 180 | 434 | 51 | 383 | 465 | 68 | 397 |

[1]*As of December each year.*
[2]*Includes points served jointly with regional carriers.*
[3]*Includes points served jointly with trunk carriers.*
*Source: Civil Aeronautics Board.*

The Interstate Highway System decreased traveltime on the ground, made major airports attractive to much larger geographical areas, and eliminated the need for many smaller surrounding airports. The trend toward larger aircraft by certificated air carriers has decreased the attractiveness of serving small points and increased the tendency toward regional airports.

Paradoxically, two programs designed to promote service to small communities have increased the tendency for local service carriers to acquire larger aircraft and have, therefore, diminished the amount of service available at small points. First, it is generally accepted that the structure of the subsidy program has encouraged carrier to procure larger aircraft. Second, the Board's route-strengthening program—designed to provide local service carriers opportunities to earn excess profits in certain markets with which to cross-subsidize service to smaller points—also encouraged carriers to buy larger aircraft.

As the number of points served by certificated carriers has been decreasing, the level of service at the remaining points has been decreasing even faster. Since the Board cannot by law control either equipment or schedules, certificated service at many points has decreased to what is usually considered the minimal level for adequate service—two flights a day. At a number of other small communities, for example, Glendive, Montana, and Devil's Lake, North Dakota, only one daily flight is provided.

In summary, certificated service has been lost by many small communities and the quality of service (measured either in terms of frequency or markets served) has been reduced at most of the small communities still served by certificated carriers. This long-term trend shows no sign of slackening and, if anything, is increasing in speed. Pressures for withdrawal in the future will grow. Local service carriers have generally expressed a desire to go off subsidy and to complete the transition to all-jet fleets. As they do so, the costs of maintaining a few smaller aircraft in a predominantly jet fleet will increase as well as the costs per passenger and subsidy needs. Thus, the long-term trend, which has already resulted in most smaller points being dropped by local service carriers, will continue.

*Changes in Service Patterns—Commuter Carriers.* Despite the withdrawal of certificated carriers from many small points, the total number of locations receiving air service has increased. This is due to the growth of commuter air carriers (previously called "scheduled air taxis"). Between 1965 and 1975, commuters replaced certificated carriers at 63 of the airports abandoned by certificated carriers. Further, they added and dropped a variety of other airports not receiving certificated service. Eighty-two airports were added and 34 dropped, for a net increase of 48. By the end of the decade, commuter carriers served 111 airports that would not otherwise have received service.[3] The future of air service to small communities—with or without changes to the regulatory environment—is expected to depend on commuter carriers.

"Commuter carrier" is a relatively new class of air carrier, established by the Board in 1952. The CAB includes any air taxi operator who scheduled at least five round trips per week pursuant to a published schedule. Commuter carriers were exempted from economic regulation so long as they operated small aircraft. Since 1970, when traffic data on commuters became available, they have grown rapidly in all respects, while certificated carriers have grown, but much more slowly. This comparative shift may be seen in table VIII.11.

Not only were commuter carriers able to increase the amount of service provided, but they did so without subsidy and in markets both thinner and shorter than those served by certificated carriers. As shown in tables VIII.12 and VIII.13, commuter carriers serve markets that are both short and thin (77 percent of their markets are less than 200 miles and 77 percent enplane fewer than 10 passengers per day). In contrast, certificated carriers tend to serve longer, denser markets (86 percent of their markets are more than 200 miles and 89 percent enplane more than 10 passengers per day).

[3]Comparing the *Official Airline Guide* for December 1965 with that of August 15, 1975.

**Table VIII.11**
**Size and Growth of Commuter and Certificated Carriers**

| | Fiscal Year 1970 | Calendar Year 1974 | Annual Growth Rate |
|---|---|---|---|
| Commuter Carriers[1] | | | |
| Carriers Reporting | 183 | 213 | 3.4% |
| No. of Flights | 807,078 | 1,029,479 | 5.6% |
| Passengers | 4,217,431 | 6,842,363 | 11.4% |
| Cargo (lb) | 38,661,227 | 138,279,017 | 32.7% |
| Mail (lb) | 69,532,851 | 156,293,120 | 19.7% |
| Certificated Carriers[2] | | | |
| Carriers Reporting | 26 | 26 | 0.0% |
| No. of Flights | 4,750,717 | 3,273,736 | Negative |
| Passengers | 152,407,139 | 185,451,513 | 4.5% |
| Cargo (lb) | 3,773,964,320 | 5,048,914,580 | 6.7% |
| Mail (lb) | 758,172,540 | 1,664,752,560 | 19.2% |

[1]*Civil Aeronautics Board of Operating Rights, Standards Division, "Commuter Air Carrier Traffic Statistics," for the years ended June 30, 1970 and December 31, 1974.*
[2]*Civil Aeronautics Board of Operating Rights, Standards Division, "Certificated Route Carriers," 12 months ending December 31, 1974, and 12 months ending June 30, 1970. Certificated carrier data are for 48 States.*

**Table VIII.12**
**Distribution of Passenger Markets by Passenger Per Day**

| Passengers per Day | Commuter Air Carriers[1] | | Certificated Air Carriers[2] | |
|---|---|---|---|---|
| | Number of Markets | Percent | Number of Markets | Percent |
| Less than 10 | 969 | 77.0 | 286 | 10.8 |
| 10-20 | 103 | 8.2 | 578 | 21.9 |
| 20-30 | 50 | 4.0 | 351 | 13.3 |
| 30-40 | 31 | 2.5 | 219 | 8.3 |
| Over 40 | 104 | 8.3 | 1,204 | 45.6 |
| Total | 1,257 | 100.0 | 2,638 | 100.0 |

[1]*Civil Aeronautics Board, "Commuter Air Carrier Traffic Statistics, Year Ending June 30, 1974," Table 3, July 1975.*
[2]*Civil Aeronautics Board, Bureau of Operating Rights, "The Domestic Route System," Table 8, October 1974. Note that the data refer to markets with single plane service. Markets where connecting service only is offered were excluded in order to make the data more comparable with commuter operations.*

**Table VIII.13**
**Distribution of Passenger Markets by Mileage**

| Mileage | Commuter Air Carriers[1] | | Certificated Air Carriers[2] | |
|---|---|---|---|---|
| | Number of Markets | Percent | Number of Markets | Percent |
| Less than 100 | 514 | 40.9 | 63 | 2.4 |
| 100-200 | 460 | 36.6 | 306 | 11.7 |
| 200-300 | 190 | 15.1 | 374 | 14.2 |
| 300-400 | 58 | 4.6 | 287 | 10.9 |
| Over 400 | 35 | 2.8 | 1,595 | 60.8 |
| TOTAL | 1,257 | 100.0 | 2,625 | 100.0 |

[1]*Civil Aeronautics Board, "Commuter Air Carrier Traffic Statistics, Year Ending June 30, 1974," Table 3, July 1975.*
[2]*Civil Aeronautics Board Bureau of Operating Rights, "The Domestic Route System," Table 9, October 1974. Note that the data refer to markets with single plane service. Markets where connecting service only is offered where excluded in order to make the data more comparable with commuter operations.*

Commuter carriers have been able to serve small markets for a variety of reasons. They tend to use small aircraft tailored to the size of the market being served. They have lower costs than certificated carriers for service of similar nature. Partially this cost difference is due to greater operational efficiency (less overhead, for example), and partially due to fewer Federal requirements. For example, commuters are allowed to operate under FAA Part 135 regulations which impose lesser requirements for smaller aircraft than the Part 121 regulations which apply to certificated carriers. A major cost saving stems from the fact that commuters need not incur security costs in screening passengers. Smaller but still significant savings arise from exemptions related to requirements imposed by the Civil Aeronautics Board (e.g., a reduction in legal fees associated with processing route cases).

Because of their use of small aircraft and operational efficiency, commuter carriers are able to provide frequent service into smaller points. As indicated in table VIII.14, the frequency of service provided by commuters is about twice as great as that provided by certificated carriers at points with the same volume of traffic. While providing more frequent service, the commuters are able to charge fares lower than, or comparable to, those of certificated carriers, at least over shorter distances. A staff study of the Council of Economic Advisers indicated that the fares charged by commuter carriers have a lower fixed component and a higher charge per mile than those charged by local service carriers. Thus, over distances up to about 100 miles, commuter fares are ordinarily lower than the fares charged by certificated carriers.

Department of Transportation studies indicate that few small points would lose all air services even under legislation that would permit more freedom of exit by certificated carriers and elimination of the present subsidy system. This reflects the fact that most small points have already lost certificated service. The trend toward abandoning small points continues at a rapid pace. During the first 2 months of 1976, certificated carriers had either withdrawn or were preparing to do so from a number of other points. Based on past trends there remains

**Table VIII.14**
**1973 Frequency of Service by Size of Point**

| Size of Point: Average Daily Passenger Enplanements | Certificated Carriers: Number of Points | Certificated Carriers: Average Weekly Departures | Commuter Carriers: Number of Points | Commuter Carriers: Average Weekly Departures |
|---|---|---|---|---|
| 1.0-4.9 | 24 | 16.5 | 59 | 21.9 |
| 5.0-9.9 | 36 | 20.3 | 50 | 28.7 |
| 10.0-14.9 | 27 | 20.7 | 25 | 46.9 |
| 15.0-19.9 | 18 | 26.6 | 21 | 52.2 |
| 20.0-29.9 | 37 | 28.8 | 27 | 58.7 |
| 30.0-39.9 | 19 | 31.2 | 17 | 56.5 |
| 40.0-49.9 | 16 | 33.6 | 12 | 60.3 |
| 50 and over | 256 | [1] | 51 | [1] |

[1]*Not calculated.*

*Source: Calculated from the data contained in Table 8, Civil Aeronautics Board, Bureau of Operating Rights, Standards Division,* A Profile of Airline Service in the 48 Contiguous States: May 1, 1973, *Washington, D.C., December 1974.*

only a 3– to 5-year stock of small points served by certificated carriers. While a few small points may retain service beyond that time, the costs of retaining one or two smaller aircraft in an otherwise all-jet fleet will also rise. There will be pressure to abandon the few remaining small points. The present regulatory system is close to the elimination of certificated service at small points and the elimination of the remaining points seems inevitable. Service to small communities could be little affected by completely eliminating protective regulation.

There is, thus, convincing evidence that service to small communities would continue if the present subsidy program for regional carriers is eliminated. In fact, the administration's proposal would guarantee replacement service by commuter airlines to any communities in danger of losing essential service without assistance.

Estimates of the costs of guaranteeing commuter replacement are provided in table VIII.15. The volume of traffic at each point reached the assumed break-even level. The high estimate is based on the assumption that replacement service would have to be subsidized at points enplaning fewer than 17 passengers per day. This involves all 50 points facing some risk of loss of service rather than the maximum of 30 estimated to face actual loss of service. The intermediate estimate is based on the assumption that all points enplaning fewer than 10 passengers per day would have to be subsidized. The threshold of 10 may itself be somewhat high since no point served by commuter carriers and enplaning as many as 10 passengers daily has lost all air service during the past 2–1/2 years. The low estimate is based on the assumption that only points enplaning fewer than six passengers per day would have to be subsidized. This is perhaps the most realistic estimate. No point having commuter service and enplaning as many as six passengers per day has lost all scheduled air service because the point itself was unprofitable during the 2–1/2 years for which data are available.

**Table VIII.15**
**Estimated Cost of Guaranteeing Commuter Replacement at All Points Dropped by Certificated Carriers**
(1975 dollars)

| | High | Intermediate | Low |
|---|---|---|---|
| Average daily passengers needed for a commuter to break even at each point | 17 | 10 | 6 |
| Total points below breakeven | 51 | 33 | 16 |
| Total passengers needed, all points | 632,900 | 240,900 | 70,100 |
| Passengers actually carried | 294,200 | 136,500 | 43,100 |
| Passenger deficit | 338,700 | 104,400 | 27,000 |
| Subsidy required[1] | $13,548,000 | $5,460,000 | $1,080,000 |

[1]*Derived by buying tickets for "phantom" passengers at $40 per ticket until each point achieves breakeven.*

Each of the three estimates is overstated to the extent that traffic is assumed to remain constant while, in fact, commuter replacement usually increases flight frequencies and generates additional traffic. Also each of the three estimates is based on the assumption that a very expensive subsidy mechanism would be employed: the Government would buy tickets for phantom passengers until the volume of traffic at each point reached the assumed breakeven level. The estimated annual costs of a new subsidy program, which would guarantee replacement service to all small points now receiving certificated service, range from $1.1 million to $13.5 million.

The proposed Aviation Act bears on the question of service to small communities in two important ways. In the first case, an amendment to the proposal insures essential service to all those communities now receiving such service from a certificated carrier as of January 1976. The CAB would be required to develop procedures for applying for subsidies and to define what constitutes "essential service."

Any community now receiving service from a certified carrier may apply, if it believes it is in danger of losing it without assistance.

If assistance is needed to maintain that "essential service," the CAB would then be required to enter into subsidy agreements with any carrier, certified or not, and found to be "fit, willing, and able" to provide the service. Most carriers receiving the subsidy would probably be commuters, although any carrier would be eligible.

The other provision in the Aviation Act that applies to service to small communities concerns the size of aircraft. The law now restricts the size of commuters' equipment to 30 seats. The Aviation Act would permit, but not require, the unregulated commuters to operate aircraft in the 30- to 55-seat range.

***Rural Airport Development.*** For many rural and remote regions, access by air can be of vital importance in encouraging development and growth, in giving access to better medical facilities, and in insuring access to interstate transportation. Therefore for some areas, the problem is not one of assuring service to small communities, but one of facilitating the development of rural airports at reasonable cost.

In the area of rural airport development needs, the administration has proposed and the Congress has acted on an extension and revision of the older Airport Development Aid Program (ADAP). This new Act, signed by President Ford on July 12, 1976, will improve airport planning and regional land-use planning related to airports in three major ways.

First, several items of airport development have been made eligible for Federal assistance. This will directly affect the impact of airports on neighboring land uses. These items include:

• *Land acquisition for environmental compatibility* — Heretofore only the purchase of land needed for airport purposes was eligible for Federal assistance. The new Act allows the Federal Government to participate in 75 percent to 90 percent of the cost of purchasing land interest to insure that neighboring land use is compatible with airport operations.

• *Noise suppression hardware, landscaping, etc., to reduce noise* — Installation and construction of noise-suppression items will directly reduce the adverse impact of airports on neighboring land uses.

• *Land-use planning* — The new 1976 Act allows airport master planning to include feasibility studies on the potential use and development of land surrounding an actual or potential airport site.

Second, Federal support of airport master planning and airport system planning will be continued under the Act. Federal funding for airport planning is authorized to be $15 million per year.

Finally, the Act requires that special studies be carried out to:

• Determine the feasibility, practicabilities, and costs of airport landbanking. Landbanking could be a powerful tool to influence land-use change in preparation for future airport development.

• Evaluate locations and carry out other planning considerations regarding the development of new large airports. This study effort would include consideration of the impact of new airports on neighboring land uses.

• Evaluate the feasibility, practicability, and cost of the soundproofing of schools, hospitals, and public health facilities located near airports.

This policy initiative to improve airport planning will be carried out through the Federal assistance and study programs already described.

For airports served by air carriers, development needs will continue to be administered by the FAA.

The FAA also has an active program to develop low-cost air traffic control and navigation facilities applicable to rural areas. These include low-cost instrument landing systems, low-cost airport towers, and low-cost wide-area coverage navigation systems.

**Hazardous Materials in Air Transportation**

Hazardous materials have been carried in aircraft since 1946 and, to date, no passenger injuries have been attributed to such carriage. However, it appears that hazardous material may have contributed to the Pan American-Boston accident of a cargo-only aircraft on November 3, 1973, in which 16,000 pounds of hazardous materials were carried, and in which three crew members were killed.

The potential hazards of different kinds of materials in the aircraft environment have to be considered from the standpoint of the potential consequences if they should (a) escape from their packaging or (b) by being packed incorrectly, generate a situation that cannot be dealt with in flight. Since air transportation is primarily designed for moving people, the greater part of cargo carried in passenger-carrying aircraft is in compartments not accessible to crew members who might otherwise have the capability to minimize a problem should it arise in flight. This has led to the two basic types of hazardous material categories, one dealing with passenger-carrying aircraft and one dealing with cargo-only aircraft.

Hazardous materials that may be carried in passenger-carrying aircraft are limited to those that meet such safety criteria that other modes of transportation exempt them from specification packing, marking, and labeling as hazardous materials. As an extra precaution when carried by air, these materials are required to be marked and labeled. There are a few exceptions to this basic requirement. Certain hazardous materials have been found to be suitable for transport in passenger-carrying aircraft by their inherent characteristics and packaging or their need to be carried (such as radioactive pharmaceuticals). These must meet further restrictions to assure an equivalent level of safety.

Hazardous materials permitted in cargo-only aircraft are limited to those that by packaging and quantity limiting will not create problems that cannot be dealt with by the flight crew. These materials must also be loaded so that they are accessible to the flight crew.

The major problem in carrying hazardous materials by air is caused by the incorrect introduction of these materials into the transportation system by the originating shipper. The packaging, marking, labeling, quantity limitation, and documentation requirements are often disregarded. This problem is compounded by the freight-forwarding agent who consolidates hazardous materials or transfers them from other modes to air transportation without observing the more stringent requirements for air transportation.

The present emphasis of the hazardous materials program as it applies to air transportation is toward education, surveillance, and enforcement. Since the FAA has no control over a shipment of hazardous materials until it reaches the air carrier, the FAA requires that the carriers train their personnel that are responsible for the handling of hazardous materials and inspect each package to assure that the regulatory requirements are met.

Because of the legal constraints placed upon the hazardous materials that may be carried in passenger-carrying aircraft and the economic factors involved in air carrier all-cargo operations as a result of increasing fuel costs and other operational factors, it is not anticipated that there will be any substantial increase in the air carriage of hazardous materials during the next 20 years. An overall average increase of 5 percent is the maximum expected.

To meet even this relatively small increase, emphasis will be maintained in the area of education, surveillance, and enforcement. Consolidation of hazardous materials regulations will be completed soon. This consolidation will permit an item-by-item evaluation of each commodity shipped as a hazardous material.

Through individual commodity identification and evaluation, increased control over shippers, and improved packaging standards, it is expected that quantity limitations will change sufficiently to allow more hazardous materials to be carried by air. In addition, by developing standards that would apply to the shipment of hazardous materials in sole-use-dedicated aircraft, by operators especially trained and closely monitored, the Department of Transportation expects eventually to permit the carriage of certain hazardous materials presently prohibited. This recognizes that air transportation is the most rapid and safe means of movement for some hazardous materials. When transported in dedicated aircraft, hazardous materials are subject to less handling, shorter exposures to the public, and easier routing away from populated areas.

**Security**

Since 1961, there have been 87 successful hijackings and 153 hijacking attempts of U.S. carrier aircraft. Worldwide, 486 hijackings have been recorded. Civil aviation security has changed considerably from the late 1960's when the Department of Transportation first placed Federal air marshals aboard U.S. carrier aircraft to protect them from hijackings.

The antihijacking program has evolved through several stages, including new regulations, new forms of security screening, and cooperative effort among carriers, airport operators, and security forces. Nevertheless, hijacking and sabotage still represent matters of grave concern.

Bombs aboard aircraft have taken a far greater toll. Since 1949, more than 242 persons have been killed aboard U.S. carrier aircraft because of explosions. Worldwide, this number is estimated to be 1,020. Bomb threats, generally anonymous and oftentimes accompanied by extortion demands, also continue to plague air carriers and airport operators. They constitute not only a constant threat to safety but also serve as an economic and operational burden to all concerned. In the United States, the number of such bomb threats has varied from year to year, and is believed to respond to a number of external stimuli, such as public events and TV programs. In 1975, 2,302 bomb threats to airlines, airports, and aircraft were reported. This compares with the peak year of 1972, in which 2,444 were reported.

The magnitude of theft-related air cargo losses is also significant and must be reduced. Theft and pilferage of air cargo are a major economic drain on the air commerce of the United States. The direct impact on the U.S. economy for theft-related air cargo losses is estimated to be in excess of $20 million a year.

The magnitude and complexity of air carrier and airport security programs are impressive. They start with the basic assumption that the people in the United States would not want their airports to be like armed camps, with access denied to all except the actual passengers and crew. They also recognize that the people would not wish to be at the airports an inordinate time before flight time. The system is designed, therefore, with these facts in mind. Every passenger and every item of carry-on baggage is screened for every certificated and supplemental air carrier flight at every airport, every day. This is possible only because of the cooperation and teamwork of all parties involved. In addition, there are thousands of law enforcement officers on duty at passenger screening points. These officers respond to actual or attempted violations of law, provide support for airline and airport security programs, and are a visible deterrent to criminal acts against civil air commerce. This protection, while successful, has not been achieved without substantial expense.

The direct cost of this program is estimated to be $100 million to $130 million per year, and is paid for by the air traveling public in the form of higher ticket prices. In addition, the lost time and inconvenience to the passenger represented by screening procedures has been more than negligible.

The security program is continually being improved. Several regulatory actions and technological advances have been completed recently and others are ready to be issued. In April 1975, two new rules went into effect: one covering the carriage of weapons by authorized persons and the escort of prisoners by law enforcement officers; the other establishing safety and detection standards and procedures governing the installation and operation of X-ray baggage inspection systems.

The rule proposing certain security requirements on foreign air carriers flying to or from U.S. airports has been subjected to intensive review due to the sensitive international issues involved. The resulting rule, effective in October 1975, complies with statutory obligations, is an effective instrument for promoting safe and secure air travel, and gives proper recognition to the legitimate interests of foreign governments and air carriers that will be affected.

Following the December 29, 1975, tragedy at La Guardia Airport in New York, in which 11 persons were killed and 55 injured when a bomb exploded in a baggage claim area, the FAA issued a rule, effective April 15, 1976, which requires screening of each piece of checked baggage. This rule complements prior rules requiring carry-on baggage screening, and heightens the U.S. air transportation security posture in the face of the increased threat. Additional actions subsequent to the La Guardia event include new explosive detection procedures for all U.S. airports and a greatly accelerated explosives detection research and development program.

Terrorism and sabotage will continue to

represent a threat to air travel. Thus, continued vigilance and continued improvement in all aspects of security will be required.

## Noise Pollution

Aircraft noise is considered a problem when it creates public annoyance or affects property values. While the absolute level of noise exposure can be measured, human reaction to noise is subjective. As a result, calling a particular level of aircraft noise "excessive" is primarily a judgment based on psychological values rather than on physiological factors.

Nevertheless, through observation and practical experience, some consensus has evolved on what constitutes excessive noise exposure.

Under these criteria, it is estimated that 7.3 million people (or 3 percent of the U.S. population) are exposed to an excessive level [noise exposure forecast (NEF) 30+] of aircraft noise. The 23 most heavily used airports, shown in table VIII.16, account for 70 percent of the total impact.

For most airports, aircraft noise was not considered a serious problem until three events of the 1950's and 1960's: (a) the introduction and subsequent proliferation of noisy jet aircraft equipment, (b) the growth of residential communities around airports, and (c) the growing concern over the environmental effects of noise exposure. In the last decade, improved aircraft design has significantly reduced noise generated by new aircraft, but the problem of adopting appropriate surrounding land use has met with considerably less success because of the costs involved.

Since 1969, the FAA has promulgated regulations specifying noise performance levels for new aircraft certification [Federal Aviation Regulation Rule 36 (FAR 36)], consistent with technological and economic considerations, and has promoted aircraft operational practices that reduce noise exposure beyond airport boundaries.

Of a total U.S. trunk and regional air carrier aircraft fleet of over 2,200, approximately 80 percent exceeds the FAR 36 regulation. As may be seen in table VIII.17, the primary sources of excessive noise are the older three- and four-engined narrow-body jets.

Foreign-flag operations at U.S. airports account for approximately 2 percent of total operations. The Boeing 707's and the McDonnell Douglas DC-8's comprise about one-third of this amount. Over half the total is concentrated at New York (JFK) and Miami airports.

**Table VIII.16**
**Population and Land Area Subjected to Aircraft Noise at Level of 30 NEF or Greater at 23 Selected Airports**

| | 1972 | | 1980 | |
|---|---|---|---|---|
| Airport | Population | Land Area (square miles) | Population | Land Area (square miles) |
| Chicago | | | | |
| O'Hare | 771,700 | 173 | 541,700 | 121 |
| Midway | 38,500 | 6 | | |
| Los Angeles | 293,400 | 28 | 205,900 | 19.7 |
| Atlanta | 99,800 | 101 | 70,000 | 70.9 |
| New York | | | | |
| Kennedy | 507,300 | 53 | 356,100 | 37.2 |
| La Guardia | 1,057,000 | 33 | 741,900 | 23.2 |
| Newark | 431,900 | 86 | 303,200 | 60.4 |
| San Francisco | 124,400 | 22 | 87,300 | 15.4 |
| Washington, D. C. | | | | |
| National | 24,400 | 7 | | |
| Dulles | 3,500 | 13 | | |
| Boston | 431,300 | 33 | 302,700 | 23.2 |
| Miami | 260,000 | 52 | 182,400 | 36.4 |
| Philadelphia | 76,900 | 18 | | |
| St. Louis | 115,600 | 28 | 81,100 | 19.7 |
| Denver | 180,300 | 35 | 126,600 | 24.6 |
| Cleveland | 128,700 | 37 | 90,300 | 26.0 |
| Minneapolis | 96,700 | 24 | | |
| Seattle | 123,200 | 42 | 86,400 | 29.4 |
| New Orleans | 32,500 | 26 | | |
| Portland | 1,200 | 11 | | |
| Phoenix | 20,500 | 10 | | |
| Buffalo | 113,800 | 38 | 79,900 | 26.7 |
| San Diego | 77,300 | 12 | | |

**Table VIII.17**
**Aircraft Noise Levels**

| Aircraft | Condition | EPNdB Over FAR 36 | Engine | Number in Service U.S. Flag |
|---|---|---|---|---|
| B-707 | Takeoff | 10 | | |
| | Landing | 10.5 | | |
| DC-8 | Takeoff | 11 | JT-3D/4D | 410 |
| | Landing | 11 | | |
| B-727 | Takeoff | 2 | JT-8D | 687 |
| | Landing | 3.5 | | |
| B-737[1] | Landing | 6 | JT-8D | 465 |
| DC-9[1] | Landing | 5 | | |

*[1]B-737 and DC-9 aircraft meet the standards for takeoff.*

Although not an FAA standard, the general objectives of noise abatement programs have been a step-by-step approach (a) to reduce the area of severe noise exposure (NEF 40+) outside of airport-controlled properties (through land acquisition, quieting the aircraft fleet, and modified aircraft operations), and (b) to reduce the area of noise disturbance through similar measures.

Federal Aviation Regulation Part 36, published in 1969, applied originally to newly type-certificated aircraft such as the L-1011, DC-10 and later versions of the 747. The regulation was subsequently broadened to include all jet aircraft coming off production lines after December 31, 1974. Extension of the regulation to in-service jet aircraft has been under study, both domestically and within the International Civil Aviation Organization (ICAO) for several years.

On October 21, 1976, President Ford directed the FAA to publish by January 1, 1977, a regulation requiring domestic commercial jet transport aircraft to meet FAR 36 noise standards in accordance with a phased-in time schedule, not to exceed 8 years. The President also asked Secretary Coleman to hold a public hearing (held December 1, 1976) to consider whether further financing arrangements may be necessary to insure that all U.S. air carriers can meet the noise standards within that schedule.

On November 18, 1976, Secretary William T. Coleman, Jr. and FAA Administrator John L. McLucas announced details of the planned rule along with other actions needed to reduce aviation noise levels. The rule will require subsonic jet airplanes with maximum gross takeoff weights in excess of 75,000 pounds that do not meet FAR 36 noise levels to be retired from the fleet or modified to meet those levels according to the following phased-in schedule:

- 747's, within 6 years, with one-half to be completed within 4 years.
- 727's, 737's, DC–9's, BAC 1–11's within 6 years, with one-half to be completed within 4 years.
- 720's, 707's, DC–8's, CV–990's within 8 years, with one-quarter to be completed within 4 years, and one-half within 6 years.

The 6- to 8-year schedule does not apply to U.S.-registered aircraft used only in international serivce or to foreign carrier aircraft. The U.S. will work through ICAO to reach agreement with other nations on equivalent international standards. If agreement is not reached in 3 years, the foreign and U.S. international aircraft now exempted will be required to meet FAR 36 noise levels at the end of 5 additional years.

**Ticket Price-Service Options**

The CAB has under the Federal Aviation Act of 1958 and its predecessor, the Civil Aeronautics Act of 1938, regulated an inherently competitive industry as if it was a public utility or a naturally monopolistic industry. Constrained by this legislation, the Board has protected markets from new entrants to limit supposedly inefficient competition. It has fixed carrier fares in an attempt to achieve cost plus "reasonable" return for carriers and to prevent "excessive" fares. Within the airline industry, the best evidence indicates that this has led to service competition whose principal long-term feature is greater capacity than would be provided in an efficient market, that is, the public generally would prefer lower air fares and higher load factors than presently exist.

Competition has been channeled toward service competition because true price competition has been limited by the regulators. In markets where a high-load-factor, low-fare-type of service meets the public's needs, such service or capacity competition wastes fuel and other resources. Examples of markets where high-load-factor, low-fare service has met with enthusiastic public response are those served by intrastate carriers in Texas and California. In the past, the CAB has frequently denied certification of such services. For example, evidence to support World Airways' application in 1967 to provide coast-to-coast service for $79 was not even heard, and was eventually dismissed 6 years later as "stale."

Alternatively, many markets, primarily those serving businessmen, are thought to be much more service oriented than price oriented. Regulated fares based on overall averages rather than on market-by-market competitive processes prevent development of higher quality, higher price service which could be desirable in such markets.

Regulatory reforms, such as proposed in Congress in 1975 and 1976, which provide for greater market-by-market pricing flexibility, freer though still restricted entry, and reform of CAB procedures, would permit tailoring services and fares to individual markets. In this way, the public's needs could be met in a more efficient manner, through the working of market forces rather than regulation of a naturally competitive industry.

Since August 1975, the CAB has approved new forms of charter travel which promise to expand the availability of low-cost air transportation to the public. The Board has authorized the operation of "one-stop inclusive tour charters," "special-event charters," and "advance-booking charters" (called OTC's, SEC's, and ABC's respectively), in a major liberalization of its charter regulations.

Under the new OTC programs, package tours, combining the economies of dense configuration, high load factors, and ground arrangements (purchased by a tour organizer at wholesale rates) at a single destination, are now possible. In addition, similar but shorter term package tours to "special events" are available under SEC programs.

During the last four months of 1975, approximately 500 OTC programs involving about 6,000 proposed flights (half domestic, half international) were filed with the CAB for 1976 operation. According to CAB reports, about half of the proposed flights were actually carried out. The Board, together with the Department of State and U.S. embassies abroad, has undertaken an extensive program of consultations in Europe to explain the new charter forms and to seek European acceptance of such U.S.-originating charters.

### Efficiency: Rationalized Air Networks

The transportation system in a network of communities should offer a balance of services provided by a combination of modes. Such a system would allow travel options within the framework of economic efficiency and public need. As one of those modes, air transportation has played an increasingly important role in transportation.

A rationalized air network should provide in an efficient manner needed service to all points that generate sufficient traffic to support it. In addition, it should provide a quality of service that meets certain standards as to available seats, quality of flight equipment, timeliness and frequency of flights, and reasonable fares. Routes should be designed to provide nonstop or one-stop service as dictated by economic efficiency without inhibiting regulatory restrictions. It is important that the aircraft utilized be suitable for the density of market and length of haul, taking into account the average 15-year lifespan of an aircraft.

The trend in air transportation has been for trunk carriers to provide long-haul service with local service carriers providing both point-to-point service between cities with a community of interest and connecting service to the trunk carriers. Meanwhile, regional carriers flying 50-passenger aircraft are suspending service to many low-density points in favor of commuters utilizing smaller turboprop and piston aircraft better suited to the markets. This trend is expected to continue with commuters playing an expanding role, primarily providing frequent connecting service from small communities to medium and large hubs in a pattern of hub and spoke service.

Major features of the future system are expected to include:

- More direct flights, with greater frequencies,
- True origin-to-destination service, from pickup at origin to delivery to final destination,
- Greater certainty in total trip times,
- Better coordinated services, particularly in the preflight and postflight segments of the journey, and
- A greater variety of charter services available.

### Airway System Improvements

With successful completion of the upgraded third-generation air traffic control system and beyond, there will be substantial improvements in the following areas:

- *Airport capacity* - Substantial gains in airport capacity through reduced separation standards, jet wake detection, closely spaced parallel runways;

• *Terminal and en route ATC* - Substantial gains in controller productivity and system safety through improved separation assurance, advanced flow control, metering, automatic data handling, spacing and area navigation;
• *Flight service stations* - Automated for substantially improved service at reduced costs; and
• *Navigation* - More widespread use of precision landing systems at problem sites and for high-capacity operations and high reliability at high-density locations. Area navigating for improving capacity, productivity, and efficiency of airspace use.

**Technological Development**
The future growth in air transportation activity will be accompanied by technological growth. Over the next 10 to 15 years, the highest growth rates are expected in the "specialized" services, particularly charter and special air cargo service. Commercial service to many more domestic points is also expected. The domestic growth pattern will moderate in average stage length and average size (seat capacity). The need to increase the quality and responsiveness of the certificated service will prevent further stage length increases. There will be more nonstop trips, and short trips will increase. Therefore, major airlines' equipment will concentrate on the intermediate size aircraft, with a large fleet of 727 aircraft versions and DC-9/737-type aircraft.

Major cities will become hubs of a distribution network that complements and enhances the surface system. This process will develop more intermodal connecting complexes than exist today.

The new generation of aircraft will follow the development pattern of the 747 SP—the first successful attempt to shrink a design and improve performance from its base configuration. It provides greater range and more flexibility at slightly lower payload, but it retains a common production line. In addition, new design efforts will be necessary to satisfy the small- and medium-size market segments. Very large aircraft (1 million pounds) will develop primarily as a cargo aircraft capable of handling intermodal containers.

General aviation will find greater application as business aircraft owned by corporations or as air taxis. The aircraft for agriculture and other utility uses will grow at past rates.

Beyond 1990, scenarios that assume a high level of overall economic performance indicate a very high rate of growth in demand for intercity travel, accompanied by an increase in the importance of trip time relative to cost. Research offers the promise of solutions to the present questions of the operational acceptability of SST aircraft, including lower noise and emission levels, sonic boom, fuel consumption, and acceptable fares. Advances in propulsion technology and aerodynamics, hopefully, will provide the key to satisfying the dual requirements of an environmentally acceptable aircraft while offering the promise of being commercially successful to its developers.

**THE FUTURE AVIATION SYSTEM**
The kind of aviation system (facilities and services) the Nation has in 1990 will depend largely on the way in which the issues discussed in the preceding sections are resolved.

For purposes of this study, it has been assumed that these issues are resolved in a manner consistent with the 1975 *Statement of National Transportation Policy*. The following actions are suggested:
• *Cost recovery* — Shift the aviation tax structure in the direction of increased user charges that more nearly reflect actual costs imposed by users on the system.
• *Regulatory reform* — Relax, but do not eliminate, regulatory constraints on entry into air carriage, abandonment of service, pricing, anticompetitive agreements, and mergers. These changes will result in a much greater range of price and service options available to the air passenger. The present regional carrier subsidy program should be replaced with a more effective program for providing service to small communities.
• *Airport access* — Foster the development of integrated limousine, ticketing, and baggage-handling systems coordinated with aircraft operations. Outside the airport boundary, airport access should be considered an important input to overall urban transportation planning.

• *Movement of hazardous materials* — Require improved material identification, packaging, handling, and shipment by sole-use-dedicated aircraft to further reduce risks associated with the slowly increasing haulage of hazardous materials.

• *Security* — Continue and improve security measures to prevent sabotage and hijacking. Promote aviation cargo security.

• *Noise pollution* — The severe noise pollution of residential areas will ease as older, noisier aircraft are phased out of the conventional jet fleet. To accelerate the process, the Federal Government will implement a noise abatement program requiring domestic commercial jet transportation aircraft to meet FAR 36 noise standards in accordance with a phased-in time schedule not to exceed 8 years. The policy that civilian aircraft may not be operated so as to produce a sonic boom over this country will be continued.

### Projected 1990 Facilities

The potential growth in aviation system facilities—principally airports and air traffic control system elements—is depicted in table VIII.18.

**Table VIII.18**
**Aviation System Elements, 1975 and 1990**

| Airports | 1975 | 1990 |
|---|---|---|
| Airports served by CAB Certified Carriers | Approximately 600 | No Significant Change[1] |
| Airports in the National Airport System Plan[2] | 3,290 | 4,066 |
| Total Airports on Record | 13,000 | Unknown |
| **Air Traffic Control/Navigation System** | | |
| Air Traffic Control Towers | 437 | 485 |
| Air Route Surveillance Radars | 95 | 112 |
| Airport Surveillance Radars | 150 | 177 |
| VOR/VORTAC (VHF Omnirange Air Navigation Systems) | 857 | 918 |
| VHF Instrument Landing Systems | 535 | 899 |

[1]*Does not reflect growth in points served by commuter carriers.*
[2]*Publicly used civil and jointly used civil/military airports within the US and its territories where "there is a national interest in providing reasonable access to the Nation's air transportation system."* The National Aviation System Policy Summary, *1000.27, Appendix 1, March 1972, Federal Aviation Administration.*

These forecasts are based on the FAA 1976 *National Aviation System Plan* and assume a continuation of the present user-charge structure, and thus, a high rate of general aviation growth. Growth in most of the system elements depicted is quite modest, ranging from well under to close to 1 percent annually.

Growth in the number of VHF instrument landing systems in the *National Aviation System Plan* is projected at a rate of 5 percent annually, a rate that might be reduced with a smaller expansion in the general aviation sector. In addition, the current development of the microwave landing system should provide improved operational capabilities during the decade.

### Projected 1990 Activity

***Air Carriers.*** Air carrier passenger-miles have increased rapidly over the last decade, primarily because of decreases in real air fares, the substitution of air for rail travel, greater affluence, more public acceptance of the safety of air flights, and a larger and comparatively younger population. In the absence of regulatory reform, the rate of growth in air travel is expected to decline substantially over the next 15 years, because of some basic shifts in these causal forces. Under regulatory reform, price competition will mean that air fares will increase much more slowly than otherwise. The forecasts shown in figure VIII.8 for air carrier passenger-miles are the likely result in a situation where fares are increasing.

Shifts in aggregate economic and demographic factors are also expected to modify past trends. The rate of increase in real income is expected to decline as a result of a projected reduction in productivity. At the same time, the rate of population growth is declining.

By projecting these various factors, but not considering regulatory reform, domestic revenue passenger-mile projected growth rates of 6.7, 6.3, and 5.9 percent per year for 1975–80, 1980–85, and 1985–90 are derived. The expected levels of overall domestic air carrier activity (without regulatory reform) are depicted in figure VIII.8. Projected growth in air carrier operations at the 24 largest hubs is depicted in figure VIII.9. About half this growth will take place in six of the hubs—New York, Atlanta, San Francisco, Los Angeles, Dallas/Fort Worth, and Miami. Operations at Chicago, now a major transfer point in the air network, will grow much more slowly than the average, as the institution of more direct ser-

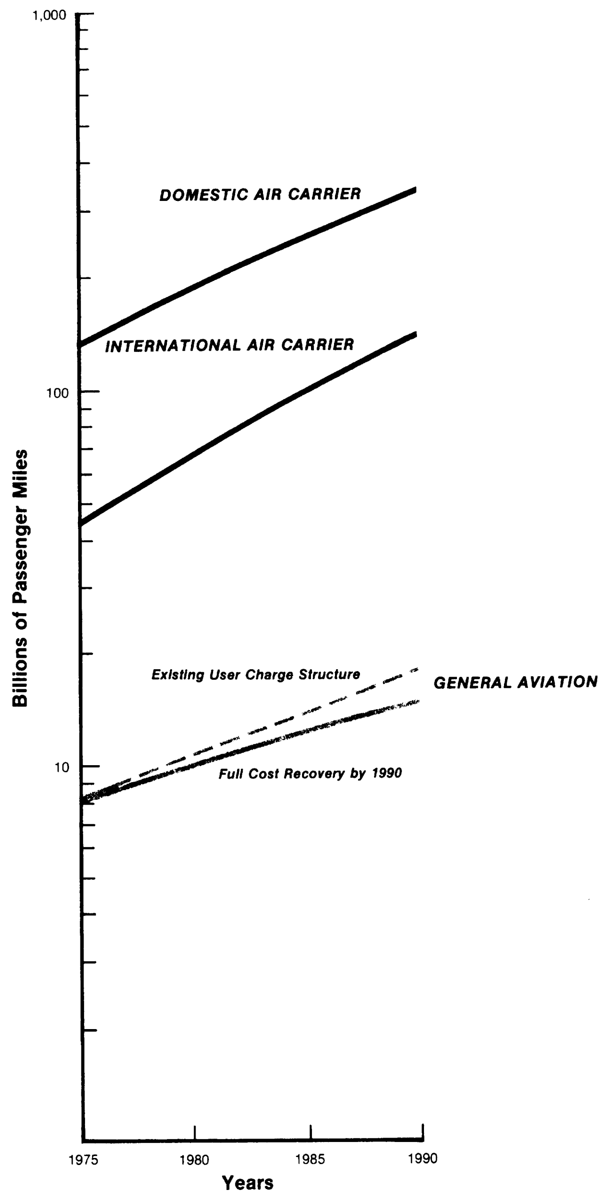



**Figure VIII.8. 1975—1990 Growth in Passenger Miles**

vice eases the need for such connecting service. In addition, the possibility of some consolidation of existing airlines might result in fewer needs for transfers and further reductions in operations.

While international air travel on U.S. carriers has grown very rapidly over the last decade, the percentage of future growth might not maintain the same high level. International traffic is expected to be affected by the same forces as are at work on the domestic market. In particular, the decline in the rate of growth of real income is expected to have a dampening effect on the rate of growth in international air travel. Competition from charter carriers should effectively reduce international air fares to attenuate this decline in rate of growth. In addition, little passenger traffic remains to be diverted from air's competitive mode, international water transportation. Taken together, these factors suggest growth rates of 9.0, 7.8, and 7.2 percent, respectively, for the 1975–80, 1980–85, and 1985–90 periods. These imply the following future levels of international passenger traffic:

| | Millions of Revenue Passenger-Miles |
|---|---|
| 1975 | 45,201 |
| 1980 | 69,547 |
| 1985 | 101,245 |
| 1990 | 143,333 |

As the principles announced in President Ford's international aviation policy statement of September 1976 are implemented, U.S. international carriers should keep and improve their share of the international market, and the consumer's service should improve.

***General Aviation.*** The growth in general aviation passenger-miles will be affected to some degree by the user-charge structure imposed. (Overall passenger-miles, which are heavily weighted by longer haul business travel, would be affected less than some other activity measures, such as total operations.) Even if the user-charge system is restructured to gradually move to full cost recovery by 1990, passenger-miles could be expected to total approximately 15 billion in 1990, some 80 percent above the 1975 level (see fig. VIII.8). A cost-based user-charge structure for general aviation will have more effect on the timing and location of general aviation activity than on the level of activity as measured by passenger-miles or operations. This is especially true of peak period activity fees employed as an alternative to airfield capacity investment. Patterns of general aviation operations by State are depicted in figure VIII.10.

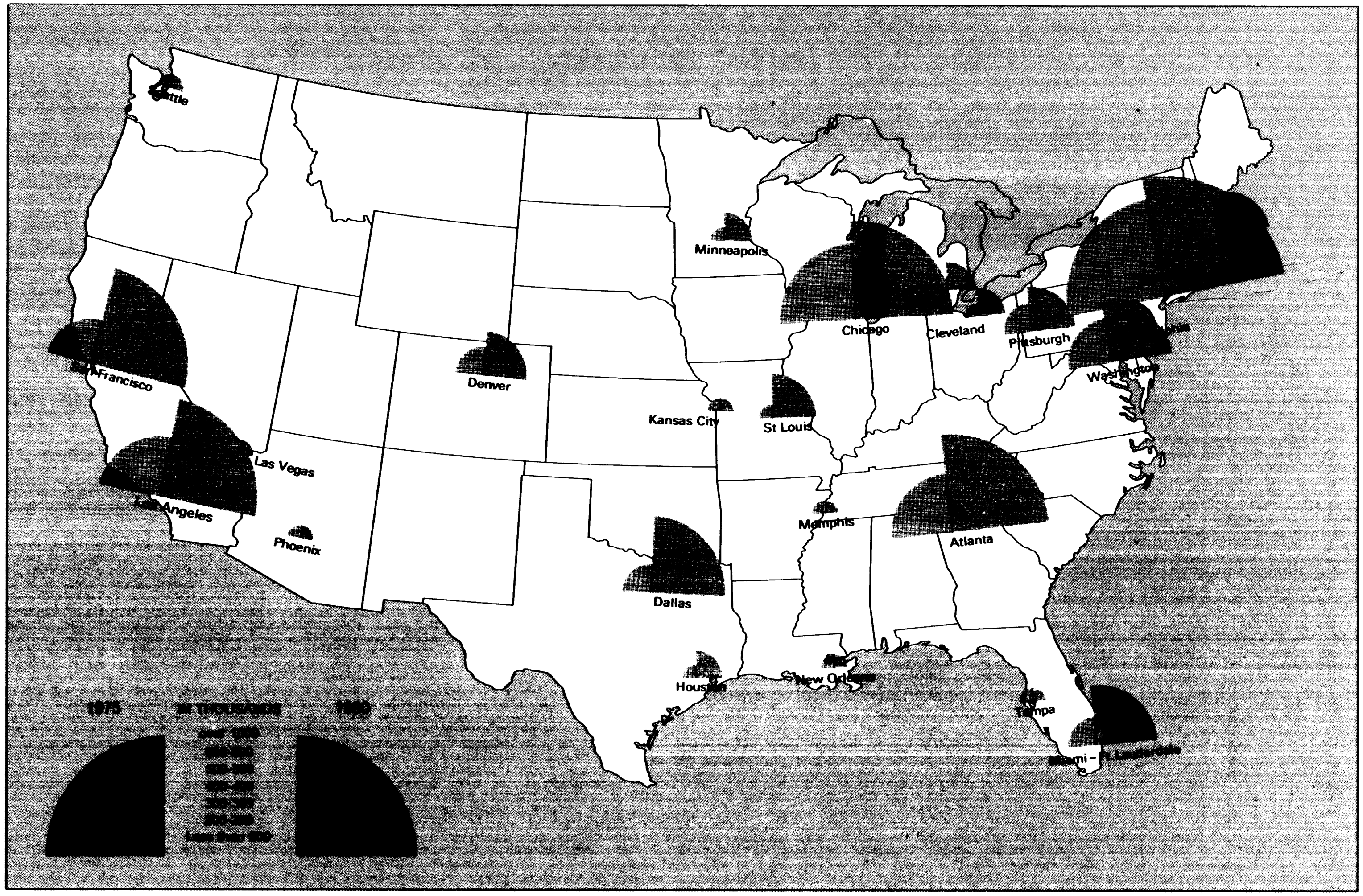
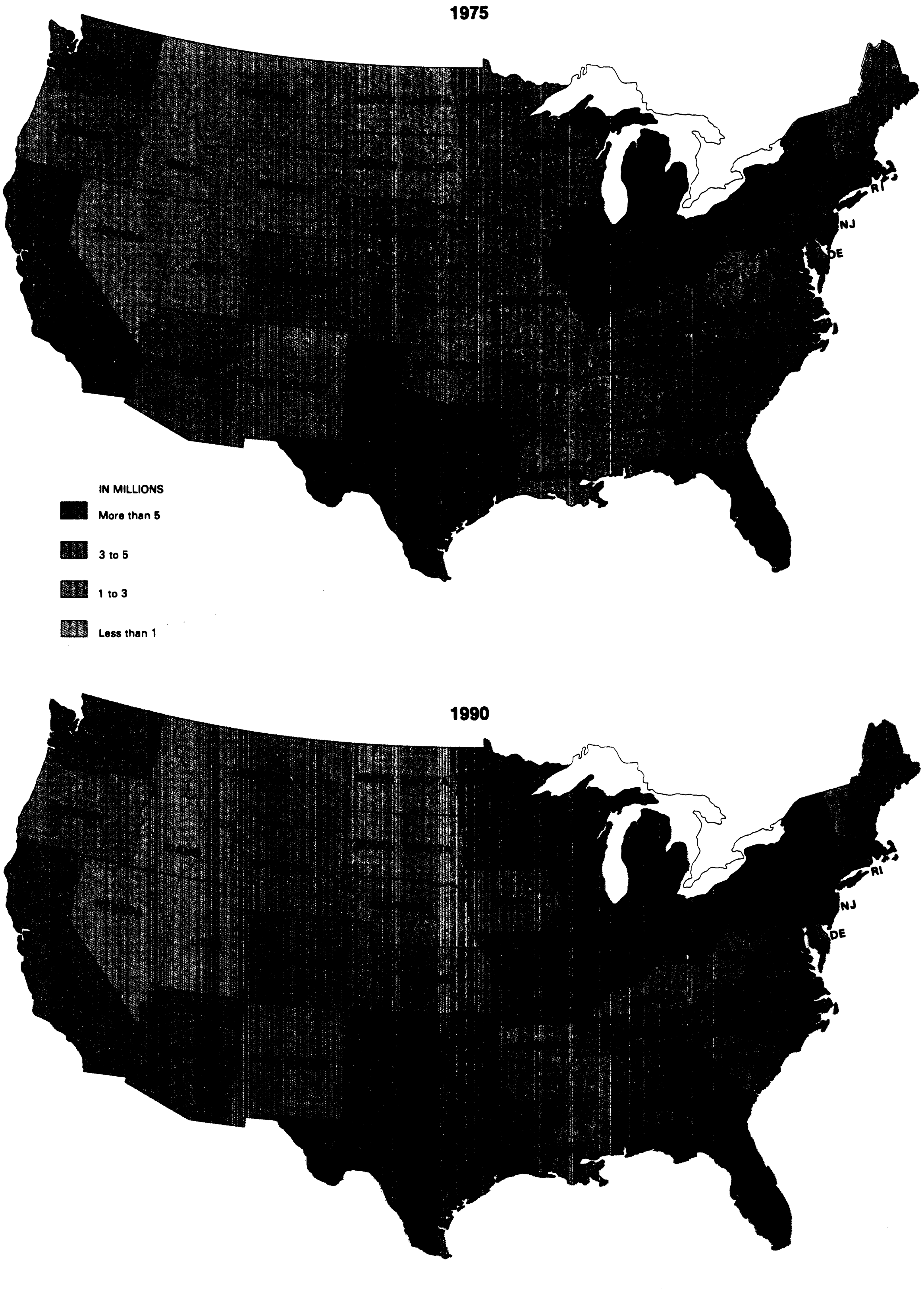



FIGURE VIII.9. 1975 AND 1990 AIR CARRIER OPERATIONS AT LARGE HUBS.




INCLUDES AIRPORTS WITH AND WITHOUT TOWERS.

[1]1990 level of operations with no change in user charge structure.

**FIGURE VIII.10 GENERAL AVIATION OPERATIONS.[1]**

***Air Cargo.*** Domestic certificated and supplemental air carriers have experienced rapid growth in the transportation of freight. Ton-miles of domestic cargoes, excluding mail, have doubled over the decade since 1966, to over 3 billion ton-miles in 1975 (see fig. VIII.11). Although air cargo domestic ton-miles represented only 0.2 percent of total intercity freight in 1975, airlines have become an important long-haul transporter of low-weight, high-value products, with extremely high rates per ton-mile, relative to other modes, being counterbalanced by the speed and quality of service. In addition, international air cargo services provide the only substitute for international water transportation of transoceanic shipments.

Certain characteristics of the air transportation industry facilitate the development of freight service. Where demand provides large tonnage for transportation between points and offers the potential of two-way traffic, cargo can be shipped in aircraft expressly designed for freight service. In addition, where freight volume is low or irregular, large belly capacities of current aircraft allow partial loads of freight on airplanes in passenger service. In 1972, 58.7 percent of total scheduled domestic shipments of the trunk carriers were shipped this way, while only 47.9 percent were transported in passenger craft in 1967. This capability of air carriers to use craft already committed to flight will provide opportunities for highly efficient use of capacity in less than full plane loads not readily amenable to other modes.

A special analysis was performed for purposes of this study to determine the overall growth of air freight and air mail. The distributions by commodity were adjusted to conform to this overall growth. This was done because past trends in growth of air freight and mail were not reliable for projection purposes. Separate analyses were made for freight and for mail.

In the case of freight, many factors indicated that the large growth rates of the 50's and 60's would not be continued in the future. Some of the factors are:

- Air freight began from such a low base that very rapid growth was feasible, but as the share increases this becomes difficult to sustain.
- Passenger growth rates have been diminishing. Because much of air freight is carried in passenger holds, this will reduce available space and frequency of schedules. The greater use of all cargo aircraft will depend on the economic efficiency of such operations.
- Air freight is more energy cost intensive than other modes and has encountered a relative disadvantage with the higher energy prices.

The projections for overall growth in yearly domestic air freight (excluding mail) are for an average growth rate of 7 percent over the next 15 years. In the case of airmail, the projected growth rate is about 2 percent per year between 1975 and 1990. This air activity rate has had a high historical growth, but now that virtually all first class mail shipped a significant distance goes by air, the growth has decreased. There has been little change in air ton-miles since 1972. Annual growth for all products, including mail, is expected to average 6.3 percent for 1975-90.

International air freight is expected to grow somewhat faster, in line with the increase in capacity available in international passenger aircraft. Annual growth is expected to average 10.1 percent for 1975-80, and 7.9 percent for 1981-90. (See ch. XIV for further discussion of international air freight movements.)

These rates imply the following future levels of air cargo traffic:

| YEAR | DOMESTIC AIR FREIGHT | INTERNATIONAL AIR FREIGHT |
|---|---|---|
| | (Millions of Ton-Miles) | |
| 1975 | 3,748 | 5,658 |
| 1980 | 5,244 | 9,157 |
| 1990 | 9,353 | 19,583 |
| | (Annual Growth Rates in Percent) | |
| 1975–80 | 6.9 | 10.1 |
| 1981–90 | 6.0 | 7.9 |
| 1975–90 | 6.3 | 8.6 |

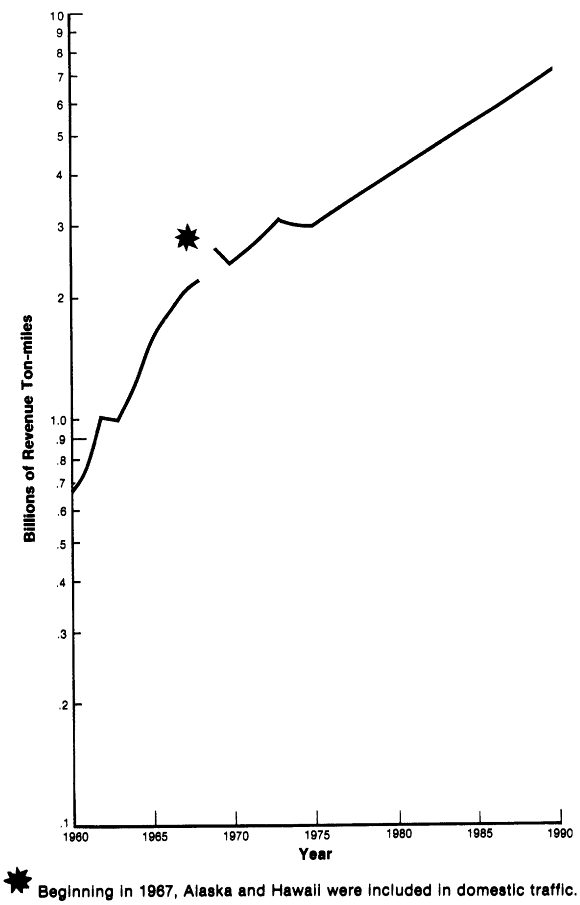



**Figure VIII.11. 1960—1990 U.S. Domestic Air Freight, Excluding Mail.**

## Forecasts of Investment

The preceding forecasts of aviation activity imply associated levels of investment in the air transportation system.

***Capital Stock/Output Based Investments.*** Based on an analysis of past relationships between levels of output and capital stock requirements, and with no change in the current general aviation user-charge structure, a total investment of $119.2 billion will be required over the next 15 years (see table VIII.19). Almost half of this (49 percent) will be required to replace worn out or obsolete equipment and structures. The remaining 51 percent will be required to purchase the capital stock necessary for expansion of the air transport system.

A comparison of investment requirements based on the current user-charge structure versus full recovery by 1990, and associated lower demand, indicates that restructuring would bring a significant reduction in investment over the next 15 years. Investment in general aviation equipment would be reduced by almost $6 billion. This would still result in a total investment of almost $28 billion in general aviation equipment by 1990. Of greater interest from the standpoint of public policy, public investment in airports and airways to accommodate general aviation aircraft would be reduced by more than $1 billion. A cut in expansion capital required to finance new airports would account for most of the reduction in public investment. Even with user-charge restructuring, public investment in airports and airways would still total $38.5 billion over the next 15 years.

As indicated earlier, the foregoing reflects the situation that would result if current trends in new airport investment continued. The fact is, however, that public concern regarding economic and environmental impacts make the continuation of past patterns of airport development unlikely. Increasing attention is being given to noncapital or relatively low-capital means of increasing airport capacity.

Noncapital alternatives range from those which are primarily administrative to those which are of a purely economic character. Two of the more frequently mentioned implementation strategies for noncapital alternatives are peak charges and airport quotas on aircraft operations at airports.

The basic concept of peak activity fees is the use of higher charges on aircraft (and/or passengers) during periods of high demand to control airport congestion. Theoretically, users confronted with such a pricing schedule will redistribute their demand more uniformly throughout the day, with only the highest valued users receiving service during the peak-demand period.

Quotas typically involve some form of rationing by fiat to restrict air traffic access to congested airports. These restrictions may be applied selectively on specific categories of aviation; they may be in force only for certain periods of a day or apply to some but not all runways of an airport.

Airport quotas are easy to describe and comprehend but difficult to create. Their first-order and short-term effects are also straightforward and predictable—as the number of flights at an airport is reduced (due to limits on the number of flights that can be scheduled or to a ban on specific types of operations), congestion at an airport also decreases. In fact,

**Table VIII.19**
**1975-90 Investment in Air Transportation**
(Millions of 1975 dollars)

| | Replacement Investment | | | Expansion Investment | | | Total Investment | | |
|---|---|---|---|---|---|---|---|---|---|
| | Equipment | Structures | Total | Equipment | Structures | Total | Equipment | Structures | Total |
| Current User Charge Structure: | | | | | | | | | |
| Total | 43,150 | 15,186 | 58,336 | 38,636 | 22,264 | 60,900 | 81,786 | 37,450 | 119,236 |
| Private | | | | | | | | | |
| Domestic Air Carriers | 16,629 | 628 | 17,257 | 13,062 | 1,616 | 14,678 | 29,691 | 2,244 | 31,935 |
| International Air Carriers | 5,838 | 143 | 5,981 | 7,786 | 247 | 8,033 | 13,624 | 390 | 14,014 |
| General Aviation | 18,106 | --- | 18,106 | 15,537 | --- | 15,537 | 33,643 | --- | 33,643 |
| Public | 2,577 | 14,415 | 16,992 | 2,251 | 20,401 | 22,652 | 4,828 | 34,816 | 39,644 |
| Airports | 532 | 13,876 | 14,408 | 246 | 19,606 | 19,852 | 778 | 33,482 | 34,260 |
| Airways | 2,045 | 539 | 2,584 | 2,005 | 795 | 2,800 | 4,050 | 1,334 | 5,384 |
| Full Cost Recovery[1] By 1990: | | | | | | | | | |
| Total | 40,998 | 14,992 | 55,990 | 35,283 | 21,517 | 56,800 | 76,281 | 36,509 | 112,790 |
| Private | | | | | | | | | |
| Domestic Air Carriers | 16,817 | 630 | 17,447 | 13,283 | 1,637 | 14,920 | 30,100 | 2,267 | 32,367 |
| International Air Carriers | 5,838 | 143 | 5,981 | 7,786 | 247 | 8,033 | 13,624 | 390 | 14,014 |
| General Aviation | 15,827 | --- | 15,827 | 12,049 | --- | 12,049 | 27,876 | --- | 27,876 |
| Public | 2,516 | 14,219 | 16,735 | 2,165 | 19,633 | 21,798 | 4,681 | 33,852 | 38,533 |
| Airports | 522 | 13,691 | 14,213 | 235 | 18,871 | 19,106 | 757 | 32,562 | 33,319 |
| Airways | 1,994 | 528 | 2,522 | 1,930 | 762 | 2,692 | 3,924 | 1,290 | 5,214 |

[1] *Assuming all reduction in general aviation traffic moves to domestic air carriers.*

since the relationship between airport demand and airport delay is nonlinear, a carefully chosen quota on the number of operations at a severely congested airport may lead to a significant reduction in the cost of delays, with a less than proportionate decrease in the number of flights allowed.

Quotas have been particularly attractive as a means of dealing swiftly and effectively with airside congestion. In 1969, for example, the FAA imposed hourly quotas on the scheduling of operations at the three New York City airports, O'Hare International in Chicago, and Washington National. These quotas helped to relieve traffic congestion at these airports. Developments since 1969 have made it possible to eliminate the quota at J. F. Kennedy and Newark. The system continues to be in effect at the other three airports.

***Benefit/Cost Based Investments.*** It is a basic premise of this planning exercise that future development of system elements should be undertaken in a benefit/cost framework in order to achieve more efficient allocation of scarce resources. The capital investment projections contained in table VIII.19 are based on historical relationships and assume a continuation of historical Federal involvement in aviation system investment. In this respect, the estimated investment levels are no more cost effective than the levels of past investment programs. To adopt a benefit/cost orientation, a methodology has been developed that projects airport system investment requirements consistent with the desire for effective resource allocation decisions over a long range.

For the airport element, two key factors are responsible for a significant part of anticipated capacity requirements. Because the cost of airport capacity is inadequately allocated among the various users of the airport facility, the demand for capacity is highly (and probably needlessly) concentrated or peaked during a few hours of the day. This results in a waste of resources in the form of needless airport capacity investment. Also, the composition of demand, i.e., the mixture of air carrier, air commuter, and general aviation aircraft, frequently contains more general aviation activity than needed for connecting services to airlines. If all costs associated with peak-period general aviation operations were passed on as a charge to these operations, it is likely that a reduction in the percentage of general aviation operating during peak periods would occur.

Peaking of demands for airport capacity by both air carrier, commuter, and general aviation operations causes congestion delay. These delays seem to be the measure of airport performance that indicates a need for additional capacity. Therefore, peaking is the major determinant of future investment levels.

The airport investment planning methodology developed for the *1974 National Transportation Study* has been applied to the 27 large-sized air transportation hub airports and to 41 medium-sized hub airports. Operational policies that control the effects of demand peaking and large concentrations of general aviation demand have been analyzed. The policy affecting demand peaks causes a spreading out of the peak period by rescheduling aircraft operations to earlier or later times of the day. This is accomplished so that total disruption of scheduled operations is minimal. General aviation concentrations in peak periods are shifted to time periods of excess capacity or are diverted to other airports.

The power of operational policies to affect capacity investment can be observed by comparison of the anticipated capacity requirements for 1990 under two conditions. One employs the operational policies and one does not. The analysis is based on forecasts through 1990 that were developed in the early 1970's and are as much as 40 percent higher than similar forecasts developed in the mid-1970's. These are the latest available for this data base. In light of the high-demand forecasts used in the analysis, the percentage reduction in capacity that can be realized when the operational policies are employed will be reported. The analysis indicates that overall capacity for the large hub airports can be reduced by 30 percent through implementation of operational policies. For medium-sized hubs that were reported to require additional capacity by 1990, it appears that a 32-percent reduction is possible. Figures VIII.12 and VIII.13 summarize the findings of the study of peaking and general aviation intensity effects for large and medium-sized hub airports where airfield capacity investments are being planned.

These figures depict the pattern of variation in the capacity-reduction capabilities of operational policies at different airports of the respective hub categories. In figure VIII. 12, it can be observed that one large hub airport is so affected by peaking and general aviation intensity that future capacity requirements can be reduced in the range of 50 to 60 percent of the capacity requirement forecast in the absence of the operational policies.

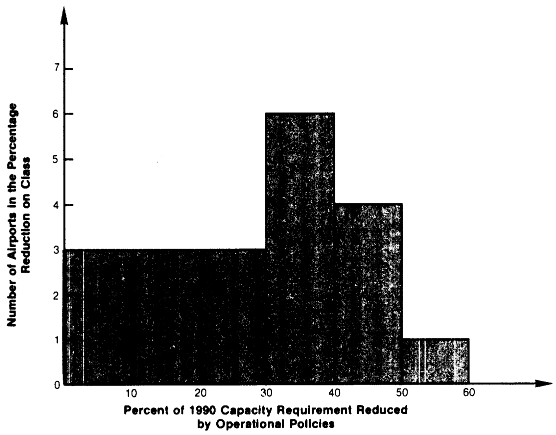



**Figure VIII.12. Percentage of 1990 Peak-Hour Capacity Requirement Reduced at Large Hub Airports When Peak Period General Aviation is Efficiently Managed.**

State planning agencies have estimated capital investments in airfields of $1.23 billion and other nonairfield area investment of $11.01 billion for the 27 large hub airports. Operational policies are able to reduce the estimated airfield investment to approximately $673 million. The States' estimates of terminal area investment include complete terminals for three new airports. These new airports appear to be unnecessary when operational policies are employed. Also, several categories of airport access facilities are included in the State estimates that were not considered in this analysis. Investment of $1.2 billion appears to be required for passenger terminal buildings and automobile parking facilities in the same 27 larger hubs. This is estimated to be a 20 percent reduction in investment in such facilities.

State agencies report a total capital investment of $2.41 billion for the medium-sized hub airports. Of this, $250 million is for airfields at 26 of the airports and $2.16 billion is for terminal area improvements at all 41 airports. Efficient management of general aviation peaking could enable a reduction of these levels to $205.41 million in airfield-capacity expansion at 6 airports and $496.89 million for terminals in all 41. By employing operational policies, capacity investment was found necessary at only 6 of the 41 medium-sized hub airports. Some terminal investments were found necessary at all of these airports. Without implementation of operational policies, it was found that 20 of the 41 airports would require additional airfield capacity.

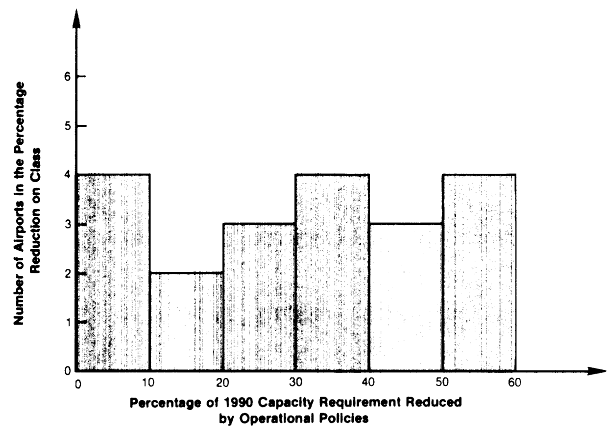



**Figure VIII.13. Percentage of 1990 Peak-Hour Capacity Requirement Reduced at Medium Hub Airports When Peak Period General Aviation is Efficiently Managed.**

## Other Performance Measures

***Energy Consumption.*** During the past 10 years, the energy consumption required to support the growth of aviation demand has tripled. Substantially more fuel is used in the 0- to 500-mile range today than is used in any of the other segments (see fig. VIII.14).

As indicated in the discussion of service to small communities, commuters and air taxi operators are expected to further expand service to smaller cities and towns, further increasing the volume of travel in the shorter stage lengths. By the year 2000, fuel requirements for air transportation are expected to double. Recent analysis has indicated that significant energy efficiencies are possible through near-term operational modifications, aerodynamic changes to the existing fleet, derivative aircraft, and new near-term and far-term aircraft. Between the present time and the year 2000, considering the overall fleet mix, improvement in efficiency could range up to 30 percent, with a fleet mix average of over 20 percent. Individual far-term aircraft have shown potential en-

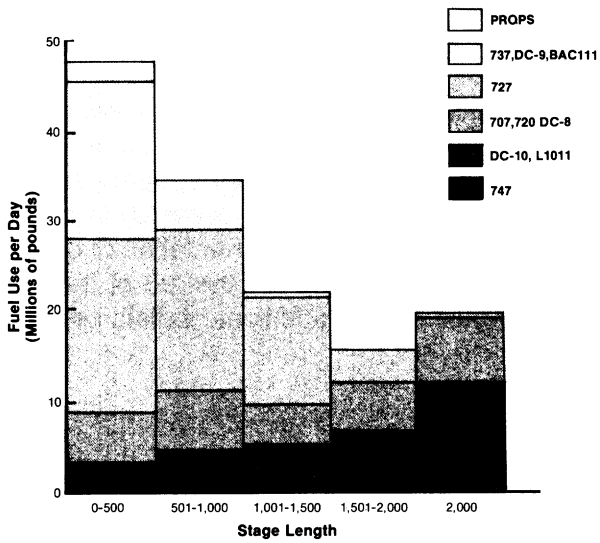



**Figure VIII.14. Average Fuel Usage of Schedule Domestic Air Carriers for August 1974.**

ergy efficiencies over existing aircraft of about 37 percent.

Significant progress in specific fuel consumption is expected. Compared to the current modern high bypass ratio turbofan, which is recognized to be much more efficient than its predecessors, improvements of 10 to 15 percent with new types can be expected (see fig. VIII.15). There is still untapped technology that could increase energy efficiency to an even greater degree. Actual development of these potential improvements depends on many factors: price of jet fuel, availability of fuel, traffic demand, and operating costs.

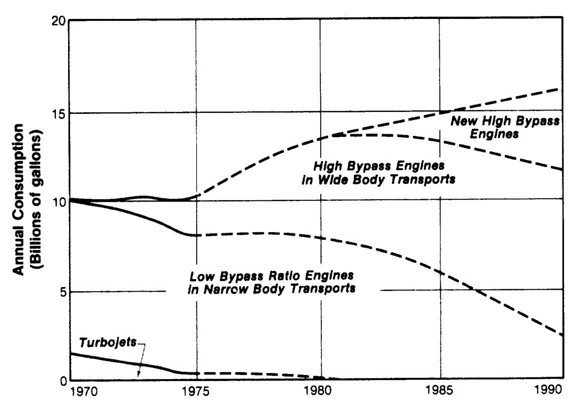



**Figure VIII.15. Forecast of Fuel Usage for Scheduled Domestic Airlines.**

Operational policies that reduce congestion at airports will reduce fuel consumption as a result of fewer delays in terminal areas.

***Environmental Impact.*** *Noise Reduction and Control.* The noise problem around an airport is a function of the number and type of aircraft that use the facility, the manner in which those aircraft are operated, the operation of the airport, and the use made of surrounding lands. Alleviation of the airport noise problem involves changes to all of these elements:

- Aircraft design
- Aircraft operations
- Airport operations

Major improvements have already been made and are expected to be made in the design of quiet engines and aircraft. Some of the criteria for the selection of sites for new airports involve the minimization of noise exposure and the ability to acquire or manage the surrounding property to minimize future noise exposure.

Implementation of an engine retrofit and/or plane replacement program will bring additional reductions in the number of persons exposed to aircraft noise. The retrofitting of JT-3D and JT-8D engines with sound-absorbing material will reduce the number of persons exposed at the 30+ NEF level of noise exposure very substantially over the next four to six years because of the large number of noisy older aircraft still in service. After these aircraft have been retrofitted or phased out and the population around airports increases, the impact of the program will taper off.

The goal of the DOT aviation noise program is to provide for the control and abatement of aircraft noise in order to afford present and future relief from aircraft noise and sonic boom.

The intent for the immediate future is to confine severe aircraft noise exposure levels (i.e., NEF 40+) around U.S. airports to those areas controlled by the airport proprietor. To the extent possible, consistent with economic judgment and technical ability, it is intended to reduce the NEF 40+ areas beyond the airports by 1980, and to assist neighboring communities in achieving compatible land use in further areas. The long-range intent is to reduce the noise-exposure levels, minimizing interference with human activities as much as possible.

*Emissions.* The projected reduction in the emission index is illustrated in figure VIII.16. A five- to tenfold reduction in emissions of $NO_x$ and other contaminants for the period between 1985 and 1990 appears possible with the development of ultra-low emissions technology.

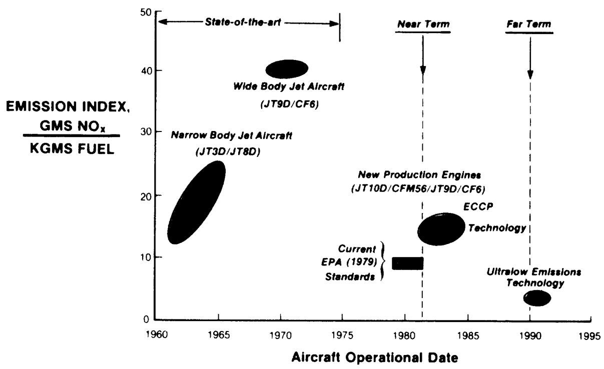



**Figure VIII.16. Impact of Technology on Aircraft Pollution levels.**
($NO_X$ at sea level takeoff conditions)

***Safety.*** *Air Carriers.* Fatal accident and fatality rates of U.S. air carriers decreased in 1975. Three fatal accidents resulted in 124 fatalities. The decrease in passenger fatalities and passenger-miles flown caused the passenger fatalities rate per million passenger-miles flown to decrease from 0.019 in 1974 to 0.016 in 1975. About three-fourths of the fatal accidents involving scheduled service aircraft occur during takeoff and landing operations; the remaining one-fourth are in-flight accidents.

Although there is a great deal of variation from year to year, accident fatalities have generally shown a gradually declining trend (see fig. VIII.17). The decline can be attributed to improved air traffic control, improved pilot training, better navigational and landing aids, and a gradual shift to aircraft with improved reliability. These factors have been great enough to more than offset the increases that might have been expected from growth in passenger-miles and the greater number of fatalities per accident with use of larger capacity aircraft.

Analysis involving use of a simple first-level model suggests that annual projected fatalities should decline to well below 100 annually by 1990 (see fig. VIII.18).

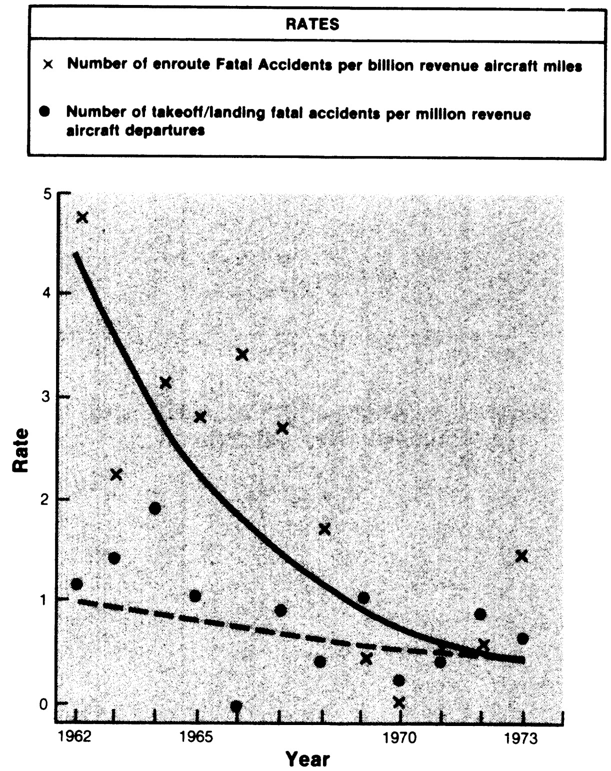



**Figure VIII.17. Accident Fatality Rates for U.S. Certificated Route Air Carriers in Domestic Passenger/Cargo Service.**

Technological developments underlying this favorable trend will include new ways to predict and assess vortex turbulence, which is a factor in 30.9 percent of air carrier accidents.

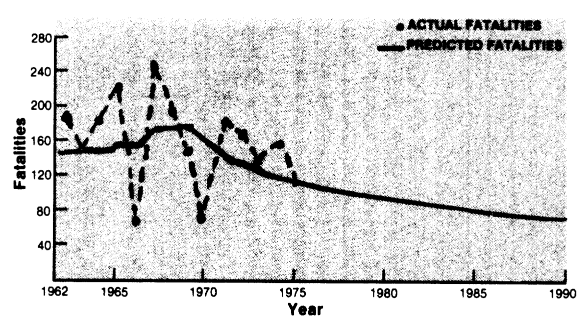



**Figure VIII.18. Actual and Predicted Fatalities of Scheduled Domestic Passenger/Cargo Air Carriers.**

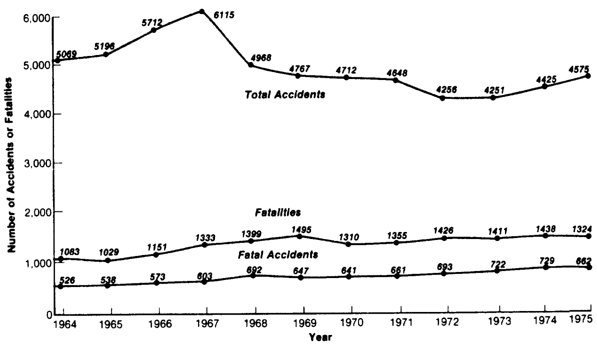



**Figure VIII.19.1964—1975 Accidents and Fatalities in General Aviation.**

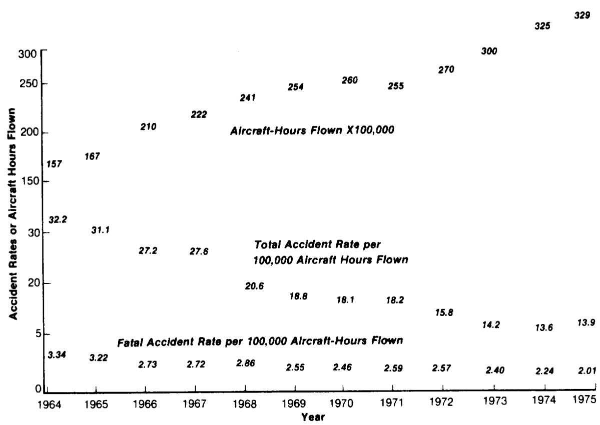



**Figure VIII.20. 1964—1975 General Aviation Accident Rates and Aircraft Hours Flown.**

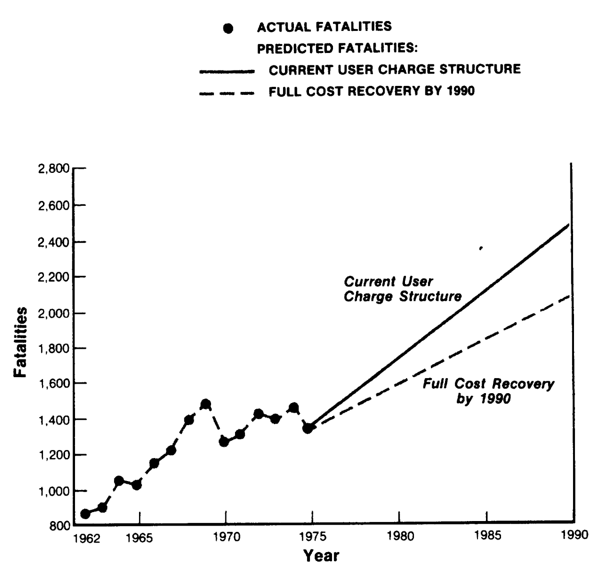



**Figure VIII.21. 1962—1990 General Aviation Fatalities.**

*General Aviation.* The general aviation safety record shows a trend of improvement over the past decade. Figures VIII.19 and VIII.20 show that there was a reduction of approximately one-eighth in total accidents although the number of hours flown increased by one-fifth. In the same period, the rate of fatal accidents has been reduced by over one-fourth.

Use of a first-level model, as described in the air carrier safety section, suggests that annual fatalities in general aviation are projected to increase significantly through 1990. Fatalities could reach almost 2,600 by 1990, given an annual level of general aviation plane-miles consistent with the current user-charge structure, or about 2,100 with the reduction in plane-miles expected in a full-cost recovery situation (see fig. VIII.21).

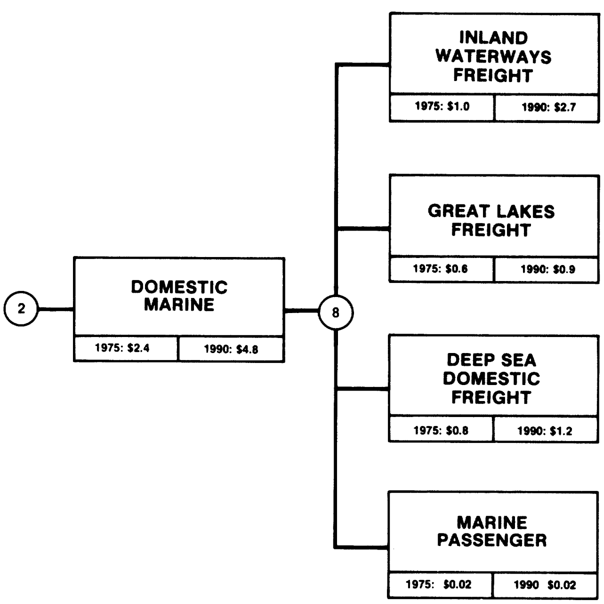
It should be noted that this first-level model does not attempt to take into consideration significantly different safety records among different types of flying. A preliminary analysis of different types of general aviation flying clearly demonstrates significant differences in fatality risk. The fatality risk in personal flying is about six times the risk factor for business flying. Since the increased user-charge alternative is expected to have a much more substantial effect on higher risk personal flying than on business flying, the improvement in the safety record may be even greater than indicated in the chart.

# CHAPTER IX
## Marine

### INTRODUCTION

Waterborne commerce has played an important role throughout the history of the United States. In the Country's earliest years, the Atlantic Seaboard States relied on water transport, not only for contact overseas but also for exchanges with each other. The early use of inland waterways and canals helped us to develop westward from the coast.

The National Waterways map, located in the envelope in the back of the book, indicates the authorized depths of U.S. ports and the average annual total foreign and domestic tonnages handled between 1970 and 1974. Figure IX.1 shows the estimated domestic marine transportation bills for 1975 and 1990.




*NOTE: The amounts shown are the transportation bills for 1975 and 1990 in billions of 1975 dollars.*

**Figure IX.1. Transportation Tree.**

Today over 99 percent of our international overseas freight trade is moved by water. Total foreign commerce[1] moved by water in 1974 was 764.1 million short-tons.[2] This represented an increase of 81 percent since 1964.

Domestically, the inland waterways, the Great Lakes-St. Lawrence Seaway system, and coastal and noncontiguous-ocean traffic are vital components of our overall national transportation system. In 1974, waterborne commerce was reported in 42 of the 50 States. During the decade from 1964 to 1974, domestic tonnage[3] carried by water increased 20 percent to 983 million short-tons (see table IX.1). Although the modal shares of tonnage have declined during this period, the marine mode carries approximately 20 percent of the total domestic tonnage in the United States.

**Table IX.1**
**Waterborne Commerce, 1964, 1969, 1973, and 1974**

| | Millions of Short Tons | | | | Billions of Ton Miles |
|---|---|---|---|---|---|
| Trade | 1964 | 1969 | 1973 | 1974 | 1974 |
| Foreign | 421.9 | 521.3 | 767.4 | 764.1 | 4013.8 |
| Domestic | 816.2 | 927.4 | 994.2 | 982.7 | 586.3 |
| TOTAL | 1238.1 | 1448.7 | 1761.6 | 1746.8 | 4600.1 |

*Source: U.S. Army Corps of Engineers,* Waterborne Commerce of the United States, 1974.

This chapter will concentrate on domestic shipping, although it is impossible to separate completely foreign commerce. For example, international movements of cargo through the Great Lakes-St. Lawrence Seaway system require the use of the system's locks and therefore have a direct impact on domestic shipping. Coastal ports obviously serve both types of commerce, and many shipments on the inland waterways have international origins or destinations. (International marine matters are discussed in chapter XV.)

Previous studies have shown that the domestic marine mode, compared with its principal competitor, the railroads, has a competitive advantage with regard to unit-carrying capacity and cost, but a disadvantage with regard to flexibility of service and speed. Decisions to ship by water are essentially long-run decisions since investments in marine facilities and equipment are, of necessity, very large. Marine mode shipments should, in general, be high volume to utilize the high line-haul capacity and relatively low unit values because of low

[1]Includes all trade between U.S. and foreign countries including the Panama Canal Zone, and between Puerto Rico and the Virgin Islands and foreign countries.

[2]Short ton = 2,000 pounds; long ton = 2,240 pounds.

[3]Includes all trade between points in the United States, Puerto Rico, and the Virgin Islands, but does not include trade with other U.S. possessions and territories. Also excludes military cargo moved in Department of Defense vessels.

speeds and the need to maintain high inventory levels. Bulk products are especially likely to be captured by the water transportation industry since they have the necessary characteristics and, in addition, can be handled by mechanized terminal facilities. (This description of the industry is, of course, not appropriate for noncontiguous States and territories that depend almost entirely on the water mode to transport all goods.) Table IX.2 lists the major commodities shipped by the domestic marine mode in 1964 and 1974.

**Table IX.2**
**Principal Commodities in Waterborne Commerce, 1964 and 1974**
**(Percent of Total Tonnage)**

| Commodity | Domestic Commerce | | Total Domestic and Foreign Waterborne Commerce | |
|---|---|---|---|---|
| | 1964 | 1974 | 1964 | 1974 |
| Petroleum and Products | 39.4 | 41.5 | 37.3 | 42.1 |
| Coal and Coke | 19.1 | 15.0 | 16.7 | 13.1 |
| Iron Ore, Iron, and Steel | 9.2 | 9.3 | 11.8 | 9.8 |
| Sand, Gravel, and Stone | 12.5 | 11.5 | 8.6 | 7.3 |
| Logs and Lumber | 3.6 | 2.7 | 3.1 | 3.0 |
| Grains | 2.1 | 2.8 | 4.8 | 5.6 |
| Chemicals | 3.1 | 5.6 | 3.4 | 5.5 |
| Seashells | 2.9 | 1.8 | 1.9 | 1.0 |
| All Others | 8.0 | 9.8 | 12.3 | 12.6 |

*Source: U.S. Army Corps of Engineers,* Waterborne Commerce of the United States, 1974.

Marine transportation is also used to a limited extent to move passengers, although total passenger-miles is small in comparison to other modes. Local and intercity passenger ferry traffic is common in some areas as is tourist cruise ship service to islands and foreign shores.

Recreational boating has become one of the fastest growing leisure activities throughout the Nation and is competing more and more with commercial users for the use of navigable waters and facilities.

## THE WATERWAY SYSTEM

The waterway system of the United States will be discussed as three separate components:

- The inland waterway system;
- The Great Lakes-St. Lawrence Seaway system;
- Coastal and noncontiguous ports.

### The Inland Waterway System

***Physical Waterways Today.*** The total inland waterway system of the United States consists of approximately 25,000 miles of navigable channels, canals, reservoirs, and lakes, making it the second largest system in the world. The U.S.S.R. waterway system is 3.5 times larger. The U.S. system, however, carries 2.2 times the tonnage (1.8 times the ton-miles). While only 20 percent of the U.S.S.R. system has a depth of at least 9 feet, 60 percent of the more highly developed U.S. waterways network has at least that depth.

The major components of the U.S. inland waterway network are:

- The Mississippi River and its tributaries, which include approximately 9,000 miles of navigable waterways, 65 percent with a minimum 9-foot channel depth (see figs. IX.2 and IX.3 and table IX.3).

- The Gulf-Intracoastal Waterway and its tributaries, which are 5,400 miles long, 50 percent with a minimum 9-foot channel depth. The mainstem of this waterway has about 1,100 miles with a 12-foot channel depth.
- The Atlantic Intracoastal Waterway and its tributaries and the New York and New England waterways, representing 7,000 miles, 60 percent with a minimum 9-foot channel depth.
- The Pacific Coast Waterways including those inland from San Francisco and the Columbia River system and totaling 3,600 miles, 65 percent with a minimum 9-foot channel depth.

As of June 1976, there were 255 navigation locks and dams being operated and maintained by the U.S. Army Corps of Engineers on the U.S. waterways. As indicated in table IX.4, lock chambers vary from 138 to 1,200 feet in length and from 30 to 110 feet in width. Filling and emptying times vary because of chamber size and total lift and range from a minimum of approximately 2-1/2 minutes to a maximum of 25 minutes.

***Future Physical Waterways.*** The inland waterway system will have few major changes between now and 1990. Channel depths are not expected to be increased.

By 1990 or earlier, new expansion and improvements will include the the Tennessee-Tombigbee Waterway, the Kaskaskia River

Waterway, and the Smithland Locks and Dam on the Ohio River.

The Tennessee-Tombigbee Waterway, now under construction, will connect the Pickwick Pool on the Tennessee River with the Tombigbee River in Alabama. The route will go north along the Tombigbee River from Demopolis, Alabama, and 168 miles of channels will be widened and deepened to make it navigable. A lateral canal of 46 miles will be constructed, followed by a 39-mile long cut through the natural divide between the two river basins. The system will include 10 locks with a total lift of 340 feet. The project, scheduled to be completed by March 1986, will shorten the waterway distance from Minneapolis, Minnesota, to Tampa, Florida, by 300 miles; from Huntsville, Alabama, to New Orleans, Louisiana, by 500 miles; and from Knoxville, Tennessee, to Mobile, Alabama, by over 800 miles.

The Kaskaskia River project, consisting of a 600- by 84-foot lock and dam at the confluence of the Kaskaskia and Mississippi Rivers, will provide a 36-mile waterway with a 9-foot depth for the coal- and grain-producing countryside of southern Illinois. Limited navigation began in February 1974, and the project is scheduled for completion by March 1980.

Smithland Locks and Dam will consist of a dam and two 1,200- by 110-foot locks and will replace locks 50 and 51 on the Ohio River. This project is expected to be completed by June 1979.

The U.S. Army Corps of Engineers estimates that major capacity constraints either exist now or will develop by 1990 at such diverse locations as Lock and Dam 26 on the Mississippi River, Inner Harbor Navigation Canal Locks, Vermilion Lock, and Port Allen Lock on the Gulf Intracoastal Waterway; Winfield Locks on the Kanawha River; Gallipolis Locks on the Ohio River; and at several locks on the Illinois Waterway and the Monongahela River.

Channel and bridge restrictions will continue to constrain system capacity through their effects on maximum tow size and speed. One-

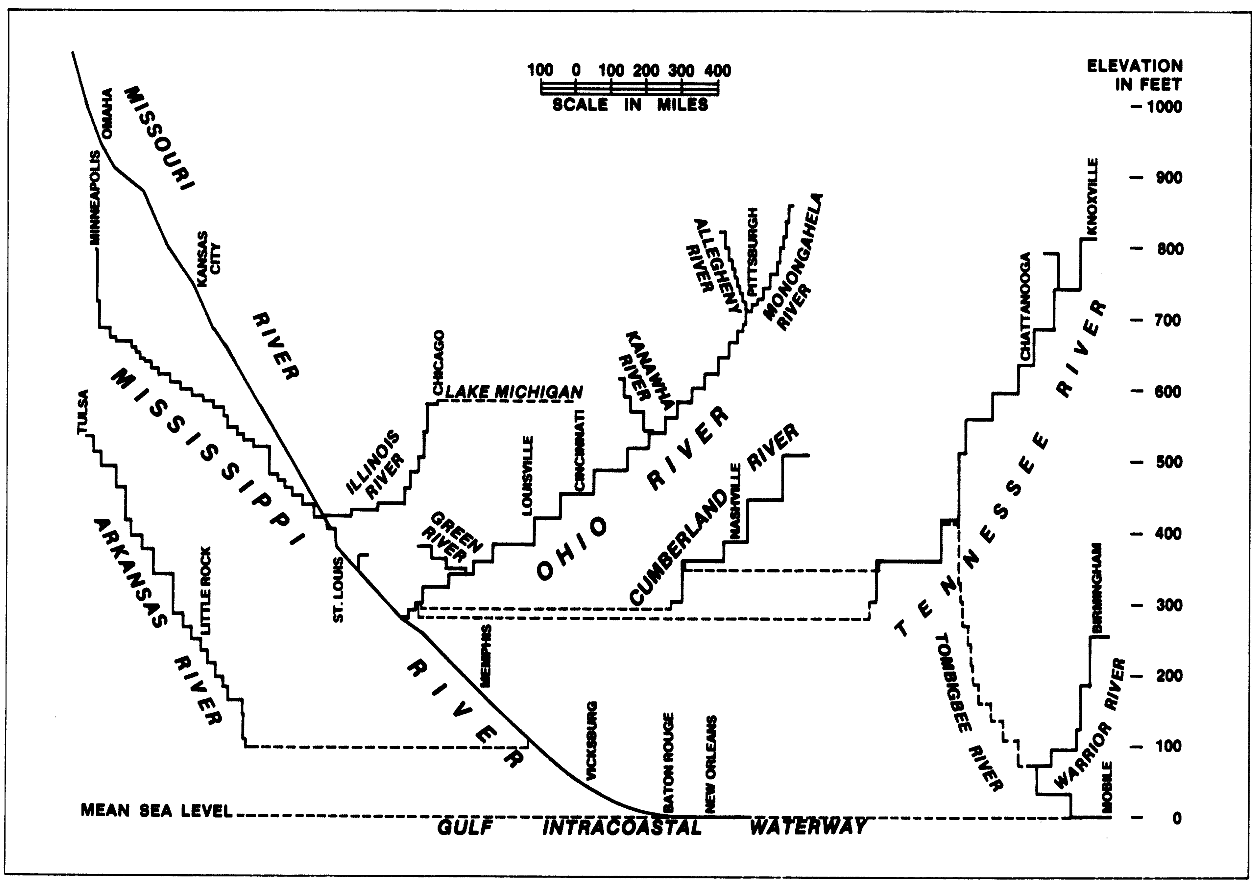
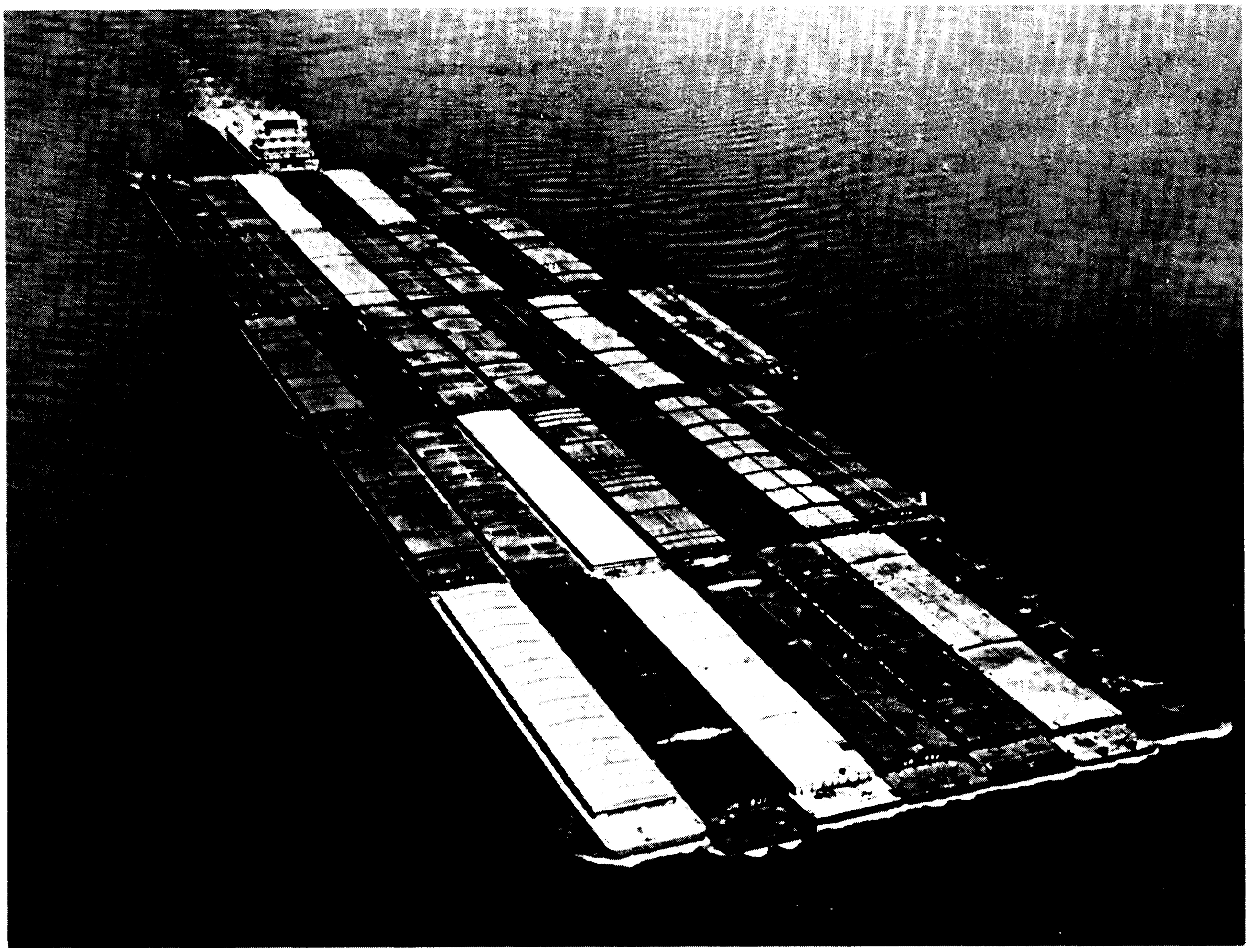
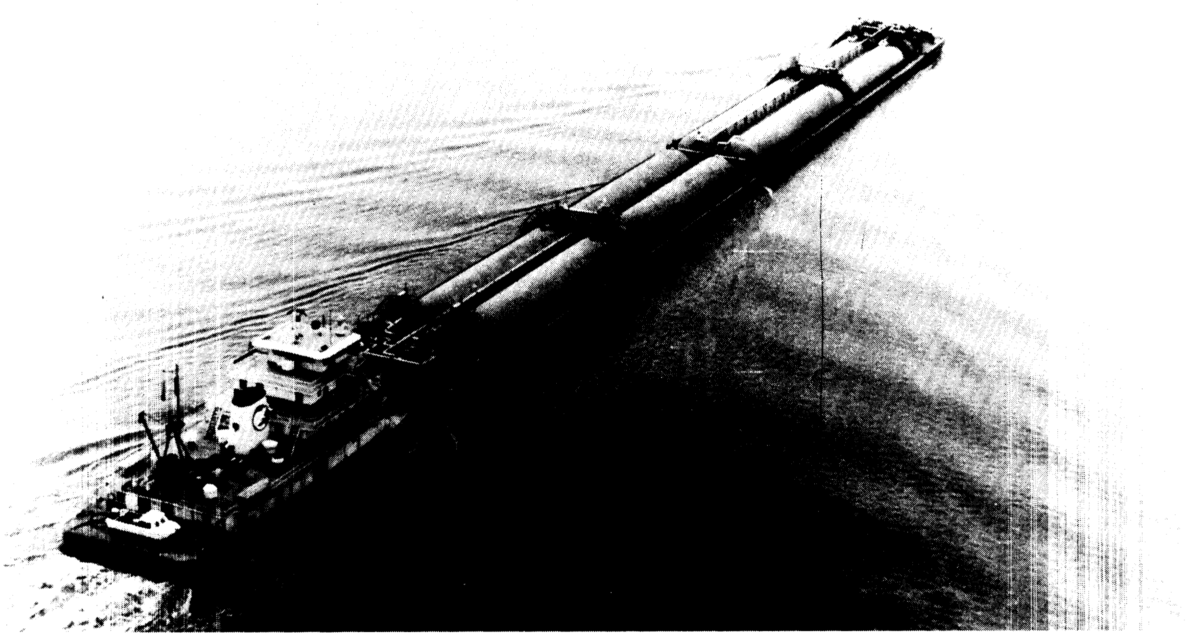



**Figure IX.2 Mississippi River System, Low-Water Profile.**

*Source: U.S. Army Corps of Engineers.*





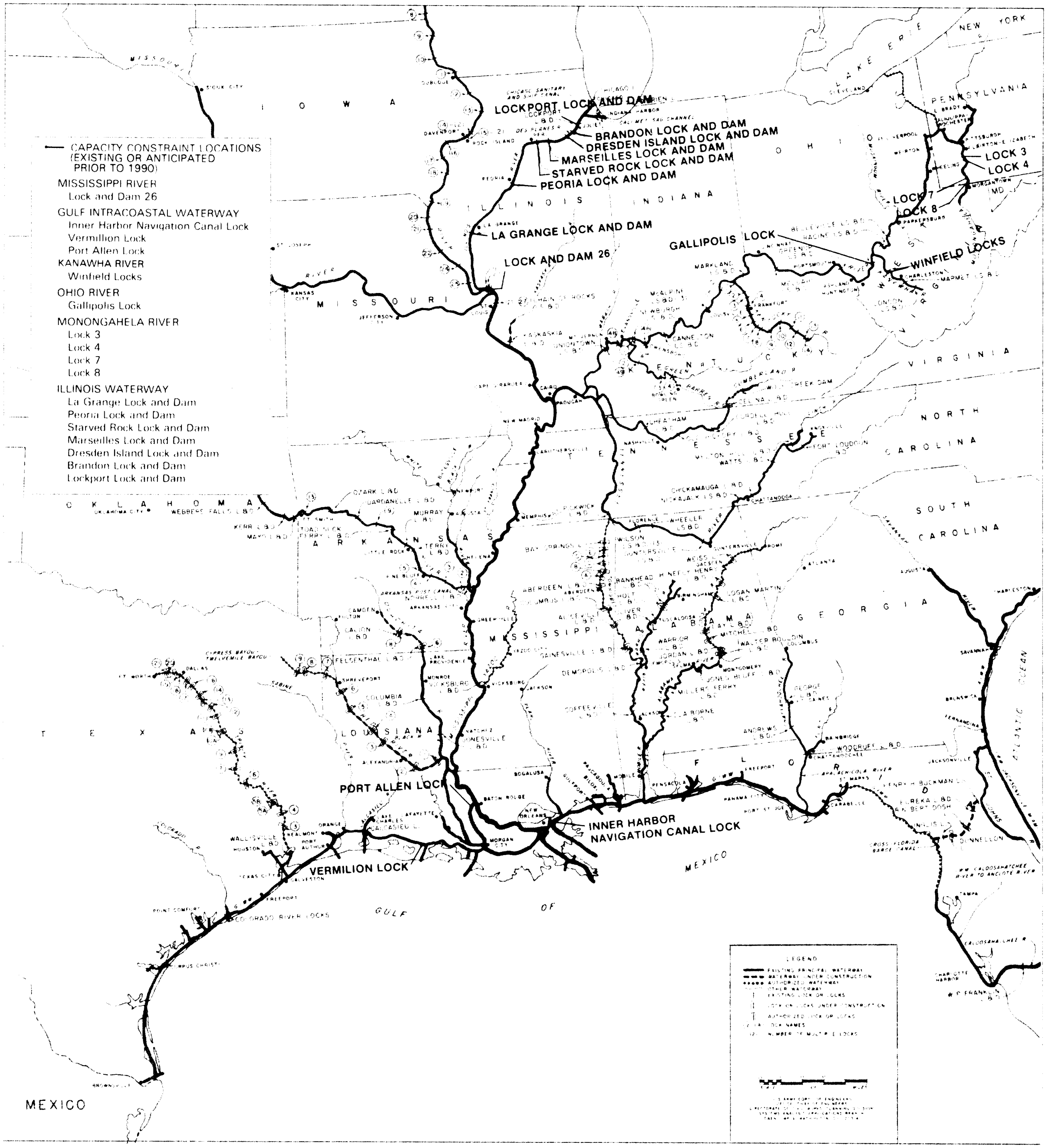



**FIGURE IX.3. MISSISSIPPI RIVER AND TRIBUTARIES AND GULF INTRACOASTAL WATERWAY SYSTEM.**

way-only traffic is required at some of these points.

***Inland Waterway Fleet Today.*** The overall size and capacity of the Mississippi River-Gulf Intracoastal Waterway fleet is shown in table IX.5.

Dry-cargo barges are almost entirely jumbo hopper barges, 195- by 35-feet with a 1,500-ton capacity at 9-foot draft. Bulk-liquid commodities are moved in a variety of tank barges ranging in capacity from 1,000 to 3,000 tons. Specialized equipment is frequently used for chemicals and other commodities.

Figure IX.4 displays recent trends in average barge capacity and utilization and, for comparative purposes, in waterborne commerce. As indicated in the figure, unit capacity has been rather stable, although capacity utilization has declined slightly despite a large increase in waterborne commerce. Fleet additions have kept pace with traffic growth. The decline in utilization reflects the normal practice of press-

**Table IX.3**
**Mississippi River System Channel Characteristics**

| Sub-Systems and Waterways | Length (miles) | Controlling Dimensions[1] (ft) | | | Max. Tow Size[2] | Navig. Season (mo.) |
|---|---|---|---|---|---|---|
| | | Depth | Width | Bend Radius | | |
| GULF INTRACOASTAL | | | | | | |
| GIWW | 1138 | | | | | 12 |
| GIWW: Brownsville-Harvey Lock | 381 | 12.0 | 125 | 1,000-3,000 | 5 | 12 |
| GIWW: Morgan City-Pt. Allen | 64 | 12.0 | 125 | UA[3] | 5 | |
| GIWW: Harvey Lock-Carabelle | 684 | 12.0 | 125 | 1,000-3,000 | 5 | 12 |
| Mobile | 45 | 9.0 | 200 | 600 | 5 | 12 |
| Black Warrior/Tombigbee | 406 | 9.0 | 200 | 400-1,000 | 6 | 12 |
| Alabama | 305 | 9.0 | 150 | 800-1,100 | 2 | 12 |
| Apalachicola/Chattahoochee/Flint | 208 | 9.0 | 80 | 400-500 | 1 | 12 |
| LOWER MISSISSIPPI | | | | | | |
| Lower Mississippi | 957 | | | | | 12 |
| Head of Passes-Baton Rouge | 237 | 9.0 | 500 | UA | 45 | |
| Baton Rouge-Cairo | 720 | 9.0 | 300 | 3,000-4,000 | 45 | |
| Atchafalaya | 155 | 12.0 | 125 | UA | 4 | 12 |
| Red | 270 | | | | | 12 |
| Jct. Atchafalaya/Jct. Ouachita/Black | 27 | 9.0 | 100 | UA | 2 | |
| Jct. Ouachita/Black-Shreveport | 243 | 5.0 | UA | UA | 2 | |
| Ouachita/Black | 337 | | | | | 12 |
| Mouth-L/D6 | 224 | 9.0 | 100 | UA | 2 | |
| L/D6 Camden | 113 | 6.5 | 100 | UA | 2 | |
| Arkansas | 459 | | | | | 12 |
| Mouth-Jct. Grand River | 396 | 9.0 | 250 | 3,500-4,000 | 9 | 12 |
| Jct. Grand River-San Bois Creek | 63 | 9.0 | 150 | 3,000 | 4 | |
| White | 255 | 4.5-5.0 | 100-125 | 400 | 2 | 12 |
| UPPER MISSISSIPPI | | | | | | |
| Upper Mississippi | 857 | | | | | 9 |
| Cairo-L/D 27 | 184 | 9.0 | 300 | 3,100 | 15 | |
| L/D 27-L/D 2 | 631 | 9.0 | 300-350 | 1,800-3,000 | 15 | |
| L/D 2-Minneapolis | 42 | 9.0 | 200 | UA | 10 | |
| Missouri | 732 | | | | | 7.5 |
| Mouth-Rulo Bend | 498 | 7.5 | 200 | 2,000-2,500 | 10 | |
| Rulo Bend-Sioux City | 234 | 8.0 | 250 | 4,800-5,600 | 6 | |
| Illinois | 357 | | | | | 12 |
| Mouth-Lockport L/D | 291 | 9.0 | 300-350 | 1,000-3,000 | 15 | |
| Chicago Lock Route | 36 | 9.0 | 175 | 500 | 15 | |
| O'Brien Lock Route | 30 | 9.0 | 200 | UA | 15 | |
| OHIO | | | | | | |
| Ohio | 977 | 9.0 | 300-350 | 1,500 | 15 | 12 |
| Allegheny | 72 | 9.0 | 300-350 | 2,000-3,000 | 12 | 12 |
| Monongahela | 129 | | | | | 12 |
| Pittsburgh-L/D 4 | 42 | 9.0 | 350 | 4,000 | 15 | |
| L/D4-Fairmont | 87 | 9.0 | 250 | 1,000-2,500 | 4 | |
| Kanawha | 91 | 9.0 | 300-450 | 2,000-3,000 | 9 | 12 |
| Kentucky | 255 | 6.0 | 75 | 500-900 | 2 | 12 |
| Green | 149 | | | | | 12 |
| Mouth-Mile 103 | 103 | 9.0 | 200 | 800-1000 | 4 | |
| Mile 103-L/D 4 | 46 | 5.5 | 200 | UA | 4 | |
| Cumberland | 381 | | | | | 12 |
| Mouth-Nashville | 191 | 9.0 | 300 | UA | 8 | |
| Nashville-Celina Dam | 190 | 9.0 | 200 | UA | 8 | |
| Tennessee | 652 | 9.0 | 300 | UA | 15 | 12 |
| Clinch/Emory | 62 | 9.0 | 150 | UA | 5 | 12 |

*[1]Controlling channel dimensions are given at Standard Low Water (the water level/discharge which has been equaled or exceeded 95-98% of the time over the total recorded number of years). [2]Calculated from Performance Monitoring System PMS) and assuming jumbo barges, 195 x 35 ft. [3]UA means data unavailable.*

*Source: U.S. Army Corps of Engineers.*

ing older equipment into service only to handle peak demands.

As a result of technological developments and competition between self-propelled vessels, push-tows, and pull-tows, the push-tow method has become practically exclusive throughout the Mississippi River-Gulf Intracoastal Waterway system. Most line-haul towboats on the inland waterway are over 100 feet long and some of the most powerful are almost 200 feet long. Most towboats have 1,000 to 8,000 horsepower, although some recently launched boats have as much as 10,000 or more horsepower. Average horsepower is now about 1,300. As shown in figure IX.5, unit towboat horsepower increased about 40 percent between 1967 and 1973, although flotilla utilization has remained relatively constant.

Practically all towboats are diesel powered and carry a crew of 6 to 15 persons, depending on the size of the tow and operating

**Table IX.5**
**1974 Mississippi River — Gulf Intracoastal Waterway Fleet**

| Vessel Type | Number | Horsepower/Capacity (tons) Total | Average |
|---|---|---|---|
| Towboats | 2,404 | 3,226,545 hp | 1,342 hp |
| Dry Cargo Barges | 17,345 | 21,031,652 | 1,213 |
| Tank Barges | 2,903 | 6,117,768 | 2,107 |
| Total Barges | 20,248 | 27,149,420 | 1,341 |

*Source: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center.*

**Table IX.4.**
**Characteristics of Navigation Locks on U.S. Inland Waterways in April 1960**

| | Number of Locks | Number of Chambers | Minimum Main Chamber Dimensions (feet) Length | Width | Depth on Sill | Lift Min. | Feet Max. |
|---|---|---|---|---|---|---|---|
| Alabama River | 3 | 3 | 600.0 | 84.0 | 13.0 | 30.0 | 45.0 |
| Allegheny River | 8 | 8 | 360.0 | 56.0 | 9.7 | 10.5 | 22.0 |
| Apalachicola-Chattahoochee Rivers | 3 | 3 | 450.0 | 82.0 | 13.0 | 25.0 | 88.0 |
| Arkansas River System | 17 | 17 | 600.0 | 110.0 | 14.0 | 14.0 | 56.0 |
| Atlantic Intracoastal Waterway | 3 | 3 | 300.0 | 52.0 | 13.1 | 3.5 | 11.0 |
| Bayou Teche | 2 | 2 | 160.0 | 36.0 | 8.0 | 9.5 | 11.0 |
| Black Warrior River | 4 | 4 | 460.0 | 95.0 | 11.9 | 22.0 | 63.6 |
| Canaveral Barge Canal | 1 | 1 | 600.0 | 90.0 | 16.0 | Varies | w/tide |
| Cape Fear River | 3 | 3 | 200.0 | 40.0 | 9.0 | 9.0 | 11.0 |
| Cayuga and Seneca Canal | 4 | 4 | 300.0 | 45.0 | 12.0 | 7.5 | 26.0 |
| Champlain Canal | 11 | 11 | 300.0 | 45.0 | 12.0 | 10.0 | 19.0 |
| Columbia River | 4 | 4 | 500.0 | 76.0 | 20.0 | 58.0 | 105.0 |
| Cross-Florida Barge Canal [1] | 3 | 3 | 600.0 | 84.0 | 14.0 | 18.0 | 28.0 |
| Cumberland River | 4 | 4 | 400.4 | 84.0 | 13.0 | 26.0 | 60.0 |
| Erie Canal | 35 | 35 | 300.0 | 45.0 | 12.0 | 6.0 | 40.5 |
| Fox River | 17 | 17 | 144.0 | 35.4 | 5.7 | 7.2 | 13.8 |
| Freshwater Bayou | 1 | 1 | 600.0 | 84.0 | 16.0 | 5.0 | -- |
| Green River | 3 | 3 | 138.0 | 36.0 | 5.2 | 12.0 | 17.0 |
| Gulf Intracoastal Waterway | 9 | 10 | 425.0 | 75.0 | 12.0 | 4.0 | 50.0 |
| Hudson River | 1 | 1 | 492.5 | 44.4 | 16.0 | 17.3 | -- |
| Illinois Waterway | 9 | 9 | 600.0 | 80.0 | 12.0 | 4.5 | 39.6 |
| Kanawha River | 3 | 6 | 360.0 | 56.0 | 12.0 | 24.0 | 28.0 |
| Kaskaskia River | 1 | 1 | 600.0 | 84.0 | 18.0 | 15.0 | -- |
| Kentucky River | 14 | 14 | 145.0 | 38.0 | 6.0 | 8.0 | 18.0 |
| Kissimmee River | 7 | 7 | 120.0 | 30.0 | 7.5 | 3.5 | 7.2 |
| Lake Washington Ship Canal | 1 | 2 | 825.0 | 80.0 | 29.4 | 21.0 | Uniform |
| Mississippi River | 28 | 36 | 320.0 | 80.0 | 7.5 | 5.5 | 49.2 |
| Monongahela River | 9 | 13 | 360.0 | 56.0 | 9.8 | 8.2 | 22.0 |
| Muskingum River | 10 | 11 | 160.0 | 36.0 | UA[2] | 9.3 | 15.4 |
| Ohio River | 21 | 40 | 600.0 | 110.0 | 11.0 | 8.0 | 37.0 |
| Okeechobee Waterway | 4 | 4 | 250.0 | 50.0 | 11.4 | 2.9 | 8.1 |
| Oklawaha River | 1 | 1 | 156.0 | 30.0 | 12.0 | 18.0 | – |
| Old River | 1 | 1 | 1,200.0 | 75.0 | UA | 65.0 | – |
| Ostrica Canal | 1 | 1 | 250.0 | 40.0 | 10.0 | UA | – |
| Oswego Canal | 7 | 7 | 300.0 | 45.0 | 13.0 | 11.4 | 27.0 |
| Ouachita-Black River | 4 | 4 | 300.0 | 55.0 | 6.5 | 9.9 | 30.0 |
| Pearl River | 3 | 3 | 310.0 | 65.0 | 10.0 | 11.0 | 26.7 |
| Sacramento River | 1 | 1 | 640.0 | 86.0 | 15.0 | 7.0 | – |
| Savannah River | 1 | 1 | 360.0 | 56.0 | 10.0 | 15.0 | – |
| Snake River | 4 | 4 | 675.0 | 86.0 | 18.0 | 98.0 | 100.0 |
| Tennessee-Clinch River | 10 | 14 | 360.0 | 60.0 | 13.0 | 39.0 | 94.0 |
| Tombigbee River | 2 | 2 | 600.0 | 110.0 | 13.0 | 34.0 | 40.0 |
| Waterway, Empire-Gulf of Mexico | 1 | 1 | 200.0 | 40.0 | 10.0 | UA | – |
| Willamette River | 1 | 5 | 210.0 | 40.0 | 9.4 | 9.3 | 20.5 |

[1] *Waterway not operational; construction has been halted.*
[2] *Data unavailable.*
*Source: U.S. Army Corps of Engineers.*

area. Since the operating costs of towboats are two to three times the total operating costs of the number of barges that make up a tow, they are normally kept underway continually, picking up and dropping off barges at fleeting areas. Medium-sized towboats (2,000–4,000 hp), for example, are used to pick up barges along the Illinois and Upper Mississippi waterways and tow them south as far as Cairo, Illinois. There, a larger towboat will form a tow of up to 45 barges, which are then pushed south to New Orleans.

Relatively new concepts in waterborne transportation are LASH (Lighter Aboard Ship) (70 by 31 feet) and SEABEE (Sea Barge) (95 by 35 feet) barges, which are used on the inland waterways and then loaded directly aboard large vessels for ocean transport; MINISHIPS, with a draft of 9 feet and carrying 1,000 tons of cargo, serve ports as far north as St. Louis and sail directly to Latin American ports. Integrated tow barges, the waterborne equivalent of unit trains, move as a unit from origin to destination without picking up or dropping off other barges along the way. These units consist of a lead barge with a rake or slope at the bow to minimize resistance through the water. This lead barge has a square stern for joining with the square end of another barge or barges that form the equivalent of a single vessel when pushed by a towboat.

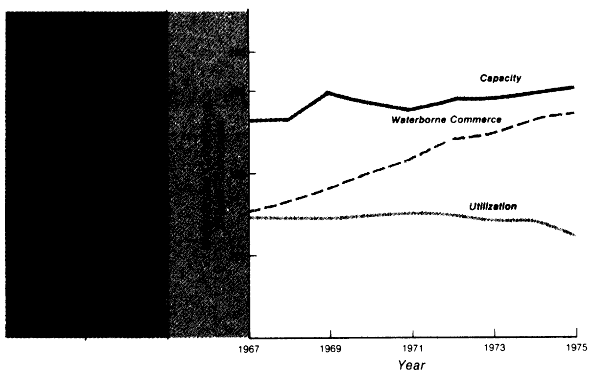



**Figure IX.4. Barge Capacity and Utilization Trends for Mississippi River and Gulf Intracoastal Waterways.**

*Source: U.S. Army Corps of Engineers.*

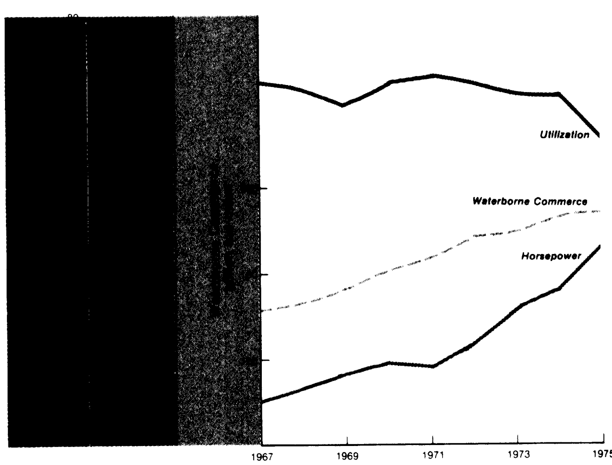



**Figure IX.5. Towboat Power and Utilization Trends for Mississippi River and Gulf Intracoastal Waterways.**

*Source: U.S. Army Corps of Engineers.*

***Future Inland Waterway Fleet.*** The projected overall size and capacity of the Mississippi River-Gulf Intracoastal Waterway fleet is shown in table IX.6. Between 1975 and 1990, towboat requirements will increase by more than 20 percent and power will increase by more than 200 horsepower. Average barge capacity will increase only slightly since waterway channel and lock dimensions preclude any large-scale enlargement of barge dimensions. The total barges required will increase by more than 40 percent. Total barge to total towboat ratio will grow from 8.4:1 to 9.8:1.

Table IX.7 gives the breakdown of towboats by type and size and also includes daily operating costs. These costs include the depreciation of reserve equipment and equipment under repair. Table IX.8 gives the breakdown of barges by type and size.

**Table IX.6**
**Projected Mississippi River — Gulf Intracoastal Waterway Fleet**

| Vessel Type | 1975 | 1980 | 1990 | Percent Increase 1975-1990 |
|---|---|---|---|---|
| Towboats | | | | |
| Number | 2,404 | 2,488 | 2,920 | 21 |
| Total horsepower (thousands) | 3,226 | 3,555 | 4,530 | 40 |
| Average horsepower | 1.340 | 1.429 | 1,550 | 16 |
| Barges | | | | |
| Dry cargo | 17,345 | 19,435 | 24,075 | 38 |
| Tank | 2.903 | 3,498 | 4,419 | 52 |
| Total barges | 20,248 | 22,933 | 28,494 | 52 |
| Total capacity (thousands) | 27,150 | 31,200 | 39,600 | 46 |
| Average capacity | 1,340 | 1,360 | 1.390 | 4 |

*Source: U.S. Army Corps of Engineers, Performance Monitoring and INSA Flotilla Model.*

**Table IX.7**
**Mississippi River — Gulf Intracoastal Waterway Towboat Projections**

| Towboat Class (horsepower) | 1975 Total Number | 1975 Operational Number | 1980 Total Number | 1980 Operational Number | 1990 Total Number | 1990 Operational Number |
|---|---|---|---|---|---|---|
| 300 | 748 | 150 | 748 | 150 | 840 | 150 |
| 600 | 436 | 250 | 436 | 250 | 488 | 250 |
| 1,200 | 610 | 555 | 610 | 595 | 660 | 650 |
| 1,800 | 210 | 103 | 215 | 105 | 300 | 145 |
| 2,500 | 91 | 93 | 93 | 128 | 128 | 73 |
| 3,300 | 134 | 88 | 163 | 59 | 187 | 124 |
| 4,300 | 73 | 49 | 88 | 59 | 128 | 76 |
| 5,000 | 36 | 36 | 44 | 44 | 61 | 61 |
| 5,700 | 32 | 32 | 39 | 39 | 55 | 55 |
| 7,000 | 22 | 22 | 28 | 28 | 37 | 37 |
| 8,400 | 11 | 11 | 15 | 15 | 15 | 19 |
| 9,000 | 2 | 2 | 3 | 3 | 6 | 6 |
| 10,100 and over | 4 | 4 | 6 | 6 | 11 | 11 |
| Total/Number | 2,404 | 1,354 | 2,488 | 1,446 | 2,920 | 1,657 |
| Annual Fuel Consumption (Thousands of Gallons) | 688.98 | | 779.33 | | 1,079.17 | |
| Total Fuel Cost ($1,000/day) | 641.4 | | 725.5 | | 1,004.6 | |
| Total Operating Cost ($1,000/day) | 2,182.0 | | 2,352.0 | | 2,831.0 | |

**Table IX.8**
**Mississippi River — Gulf Intracoastal Waterway Barge Projections**

| Type | Size | 1975 Number | 1975 Cost $1000/day | 1980 Number | 1980 Cost $1000/day | 1990 Number | 1990 Cost $1000/day |
|---|---|---|---|---|---|---|---|
| OH | 245 x 35 | 245 | 22.8 | 245 | 22.8 | 306 | 28 |
| OH | 195 x 35 | 5,490 | 417.2 | 6,300 | 478.2 | 8,730 | 663 |
| OH | 175 x 26 | 2,890 | 150.3 | 2,900 | 155 | 2,900 | 155 |
| OH | 120 x 30 | 1,172 | 46.9 | 1,170 | 46 | 1,170 | 46 |
| CH | 195 x 35 | 4,650 | 558.0 | 5,950 | 714.0 | 7,600 | 910 |
| DK | 200 x 50 | 348 | 38.3 | 350 | 38 | 435 | 47 |
| DK | 195 x 35 | 510 | 28.8 | 520 | 39 | 924 | 69 |
| DK | 150 x 32 | 810 | 42.1 | 810 | 42 | 810 | 42 |
| DK | 100 x 26 | 1,230 | 38.1 | 1,200 | 38 | 1,200 | 38 |
| TN | 290 x 53 | 573 | 114.6 | 688 | 138 | 867 | 174 |
| TN | 240 x 50 | 760 | 136.8 | 910 | 164 | 1,147 | 207 |
| TN | 185 x 54 | 322 | 51.5 | 320 | 51 | 320 | 51 |
| TN | 195 x 35 | 790 | 86.9 | 1,120 | 123 | 1,625 | 178 |
| TN | 135 x 40 | 458 | 41.2 | 460 | 41 | 460 | 41 |
| | Total | 20,248 | 1,783.5 | 22,933 | 2,084 | 28,494 | 2,649 |

*OH = open hopper* *CH = covered hopper*
*DK = deck* *TN = tank*
*Source: U.S. Army Corps of Engineers, Performance Monitoring System and INSA Flotilla Model.*

***Inland Waterways Freight Today.*** Inland waterway freight traffic during the 15 years between 1959 and 1974 grew substantially, with a 111-percent increase in ton-miles and an 81-percent increase in tons. From 1949 to 1974, the growth was more dramatic as ton-mileage rose 488 percent and tonnage rose 208 percent. Its share of the multimodal market, however, grew less sharply. Between 1959 and 1974, the ton-mileage share increased 33 percent (7.6 percent to 10.1 percent) and that for tonnage was up 19 percent (8.0 percent to 9.5 percent). The 25-year shift amounted to 173 percent for ton-mileage (3.7 percent to

10.1 percent) and 51 percent for tonnage (6.3 percent to 9.5 percent). The inland waterways in 1974 accounted for 42 percent of the ton-miles and 57 percent of the tons of domestic waterborne commerce. In contrast, its shares 15 and 25 years ago were only 25 percent and 12 percent for ton-mileage and 46 percent and 35 percent for tonnage. Table IX.9 shows the waterborne commerce on the major waterways of the Mississippi River system for 1964 and 1974.

The average line-haul cost of moving cargo on the inland waterways in 1975 was approximately 5 mils per ton-mile.

***Future Inland Waterways Freight.*** Preliminary projections of future freight flows on the inland waterways were provided by the U.S. Army Corps of Engineers using their Inland Navigation Systems Analysis program (INSA). Several authorized projects were not included in the simulations for 1990 since it is doubtful that they could be completed before that time. These projects include widening and deepening of the Gulf Intracoastal Waterway from St. Marks to Tampa, Florida. The economic efficiency of this project is partly dependent on the Cross Florida Barge Canal, construction of which was halted in 1971 with the project 40 percent completed. Work on the Trinity River navigation project in Texas was halted in 1973. Canalization of the Red River in Louisiana and Texas has not been started. A recent restudy of the Coosa River project has indicated that it will probably not be built.

The projections made by the Army Corps of Engineers were based on the assumptions that the authorized 110- by 1,200-foot lock at Gallipolis on the Ohio River will be constructed and that a single 110- by 1,200-foot lock at Locks and Dam 26 at Alton, Illinois, on the Mississippi River will be authorized.

The traffic projections were made on the assumption that future channel, lock, and port improvements needed to accommodate traffic increases will be made in a timely fashion. Failure to maintain adequate channel depths or failure to replace outdated locks constituting serious bottlenecks could inhibit the growth of waterway traffic.

Table IX.10 lists the commodity-flow projections for all U.S. internal traffic, including all inland waterways, large bays such as the Chesapeake and Delaware, and large bodies of open water such as Puget Sound. Coastal, Great Lakes, and noncontiguous trade are excluded.

**Table IX.9**
**Commerce on Major Waterways of the Mississippi River System, 1964 and 1974**

| Waterway | 1964 Tons | 1964 Ton-Miles (in thousands) | 1974 Tons | 1974 Ton-Miles (in thousands) |
|---|---|---|---|---|
| Allegheny River, Pennsylvania (improved portion) | 4,866,638 | 56,614 | 5,532,052 | 87,302 |
| Atchafalaya River, Louisiana | 4,956,331 | 503,423 | 4,552,884 | 402,624 |
| Barkley Canal, Kentucky | – | – | 4,699,038 | 9,398 |
| Cumberland River, Kentucky, and Tennessee | 2,976,635 | 435,102 | 11,034,025 | 982,503 |
| Green and Barren Rivers, Kentucky | 10,363,520 | 928,116 | 15,639,721 | 1,426,247 |
| Illinois River, Illinois | 26,614,651 | 5,041,478 | 41,229,726 | 8,190,996 |
| Kanawha River, West Virginia | 12,509,454 | 671,152 | 12,781,026 | 713,681 |
| McClellan-Kerr, Arkansas | 1,029,899 | 4,797 | 6,000,443 | 451,109 |
| Minnesota River, Minnesota | 2,339,271 | 30,317 | 4,778,630 | 67,851 |
| Upper Mississippi River | 72,624,827 | 11,914,641 | 132,008,694 | 23,169,452 |
| Lower Mississippi River | 54,011,706 | 30,030,859 | 111,381,795 | 65,417,419 |
| Missouri River, Missouri | 7,633,415 | 1,126,958 | 7,673,084 | 1,227,525 |
| Monongahela River, Pennsylvania | 37,840,677 | 1,771,643 | 38,265,899 | 1,641,720 |
| Ohio River | 96,371,713 | 21,324,563 | 139,294,213 | 31,945,085 |
| Tennessee River, Kentucky, and Tennessee | 15,373,902 | 2,053,905 | 27,123,623 | 3,578,809 |

*Source: U.S. Army Corps of Engineers.*

These projections indicate that U.S. internal waterborne traffic is expected to grow almost 40 percent in the 15-year period between 1975 and 1990. Traffic flows on the two waterway expansions, the Tennessee-Tombigbee River and the Kaskaskia River are not included in table IX.10, but are conservatively estimated to be 17.4 and 7.8 million tons, respectively, in 1990.

Table IX.11 shows the projected commodity flows for major river systems of the inland waterways.

**Table IX.10**
**Commodity Flow Projections — U.S. Internal Waters**

| Commodity Class | Short Tons (in 000) 1975 | 1980 | 1990 |
|---|---|---|---|
| Grain and farm products | 35,384 | 37,430 | 46,085 |
| Coal and lignite | 132,070 | 147,918 | 187,389 |
| Crude petroleum | 79,142 | 80637 | 84,964 |
| Petroleum products | 189,638 | 214,859 | 272,242 |
| Nonmetallic minerals | 87,529 | 92,169 | 104,356 |
| Metal ores | 5,367 | 5,738 | 10,678 |
| Primary metals | 13,712 | 14,673 | 17,655 |
| Metal products and machinery | 3,125 | 3,616 | 4,813 |
| Chemicals and products | 46,983 | 57,837 | 87,676 |
| Lumber | 2,206 | 2,432 | 3,007 |
| Pulp, paper, and allied products | 20,933 | 24,910 | 35,876 |
| All other | 40,525 | 46,843 | 63,022 |
| Total | 656,614 | 729,062 | 917,763 |

*Source: U.S. Army Corps of Engineers,* Inland Waterway Study for the National Transportation Plan, *April 1, 1976. Forecasts of inland waterway traffic in accordance with guidelines established by the Department of Transportation.*

**Table IX.11**
**Commodity Flow Projections for Major River Systems**

| River System | Millions of Short Tons 1975 Shipped | 1975 Received | 1980 Shipped | 1980 Received | 1990 Shipped | 1990 Received |
|---|---|---|---|---|---|---|
| Lower Mississippi | 93.1 | 98.2 | 103.3 | 106.6 | 127.5 | 129.8 |
| Upper Mississippi | 42.1 | 29.2 | 46.2 | 32.6 | 63.5 | 46.1 |
| Ohio | 31.1 | 93.4 | 89.3 | 103.5 | 119.2 | 124.0 |
| Illinois | 28.1 | 29.3 | 20.9 | 32.7 | 36.8 | 40.0 |
| Gulf Intracoastal-Waterway-East | 169.5 | 83.1 | 188.7 | 91.1 | 234.2 | 110.8 |
| Gulf Intracoastal-Waterway-West | 29.2 | 26.1 | 32.4 | 29.2 | 27.8 | 27.3 |
| Monongahela | 33.9 | 31.4 | 37.9 | 35.0 | 43.7 | 40.4 |
| Tennessee | 15.8 | 20.5 | 17.5 | 22.2 | 21.5 | 32.3 |
| Kanawha | 9.2 | 9.8 | 10.4 | 11.3 | 12.3 | 14.7 |
| Green/Barren | 18.2 | 0.7 | 20.3 | 0.7 | 23.3 | 8.3 |
| Mobile/Alabama/Tombigbee/Black | 9.2 | 10.6 | 10.1 | 11.6 | 32.1 | 38.9 |
| Missouri | 6.4 | 6.0 | 7.0 | 6.6 | 8.5 | 8.3 |
| Total Inland Waterways | 562.7 | | 622.6 | | 774.1 | |

*Source: U.S. Army Corps of Engineers* Inland Waterway Study fór the National Transportation Plan, *April 1, 1976 (Forecasts of Inland Waterway Traffic in accordance with National Transportation Plan guidelines established by the Department of Transportation).*

## Great Lakes–St. Lawrence Seaway System

***Physical Waterways Today.*** The five Great Lakes, their connecting locks and channels, and the St. Lawrence River form an improved waterway system extending 2,342 miles from the western end of Lake Superior to the Atlantic Ocean (fig. IX.6). The lakes segment of the system, covering an area of 95,000 square miles, probes deeply and multidirectionally into the midcontinent ultimately to link with the Mississippi River network at the southen end of Lake Michigan. Geographically, and more importantly as a transportation routing option, the system is essentially an inland waterway with an outlet to the sea, competing for cargo with parallel overland routing to domestic destinations and to the seaboard for overseas movements.

With its wide and deep lakes, the waterway is 90 percent navigable in its natural state, posing constraints on vessel size and draft only at harbors and in the connecting channels and rivers of the system. Major improvements to the system have therefore focused on the connecting channels where sections of falls and rapids (due to differing lake levels) have been surmounted with navigation locks and canalization. These focal points of right-of-way investment are found (a) in the St. Lawrence River; (b) at the Welland Canal, between Lake Ontario and Lake Erie; (c) in the Detroit-St. Clair River, between Lake Erie and Lake Huron, and (d) in the St. Mary's River connecting Lake Huron with Lake Superior. Vessels traversing this route are raised 602 feet above sea level through a series of 16 locks stretching from tidewater at Montreal to the "Soo" locks of the St. Mary's River at the entrance to Lake Superior (fig. IX.7).

The Great Lakes-St. Lawrence waterway is almost uniquely international throughout its sweep with the United States-Canada international boundary following the trace of the French fur trade route established in the late 17th century. Waterway improvements are found on both sides of this line, and control of the navigation channels frequently shifts from one jurisdiction to the other. As a consequence, development on a systems basis generally requires the cooperative efforts of both governments.

One such cooperative effort is found in the multipurpose development of the St. Lawrence River section stretching from Montreal west to Lake Ontario. The St. Lawrence River project, a joint U.S.-Canadian undertaking completed in 1959, provided a 27-foot channel throughout the entire system and replaced 22 small St. Lawrence locks with 7 new and larger locks. Navigation through the canals and locks of the St. Lawrence section is administered by two government corporations—the U.S. St. Lawrence Seaway Development Corporation and the Canadian St. Lawrence Seaway Authority. In addition to their operational responsibilities, these government entities are charged with recovering, through a tariff of tolls or user charges, the full costs, including investment, of

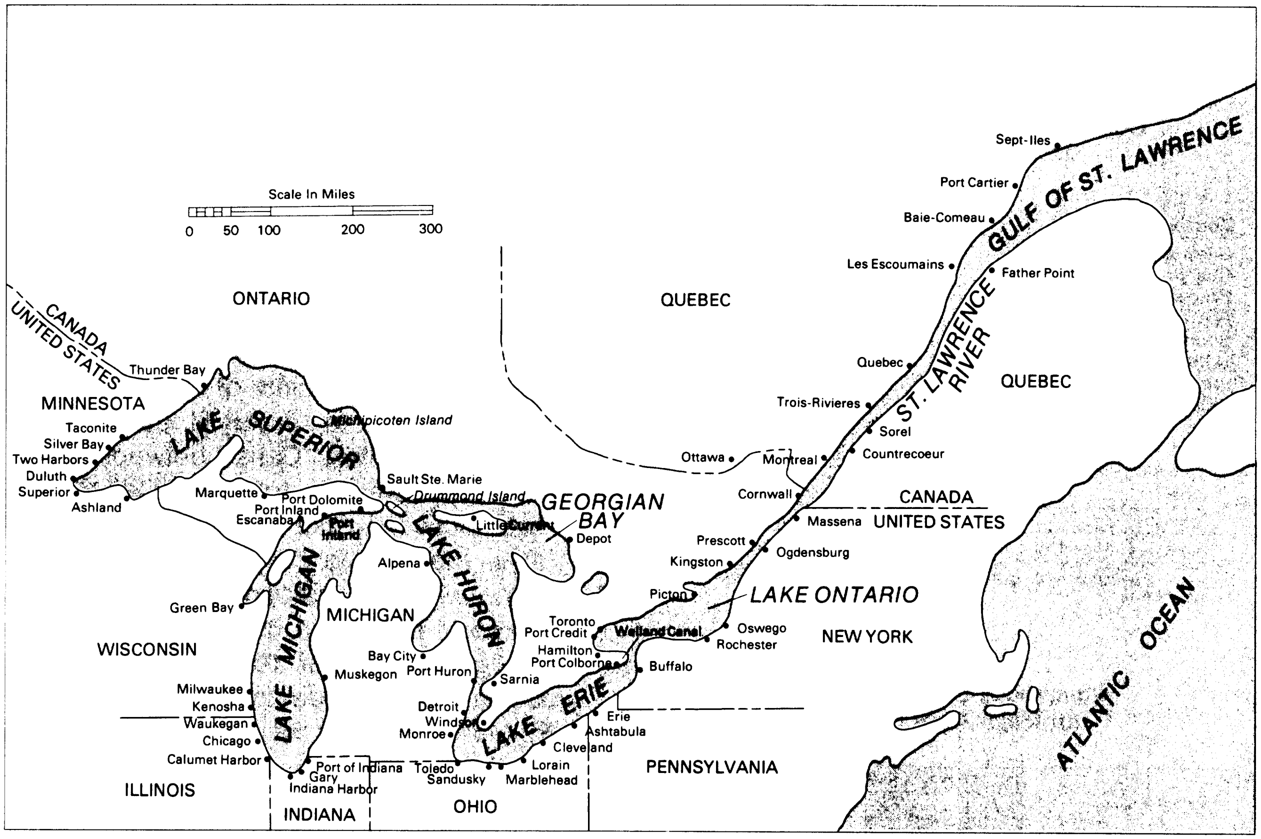



**Figure IX.6. The Great Lakes—St. Lawrence River.**

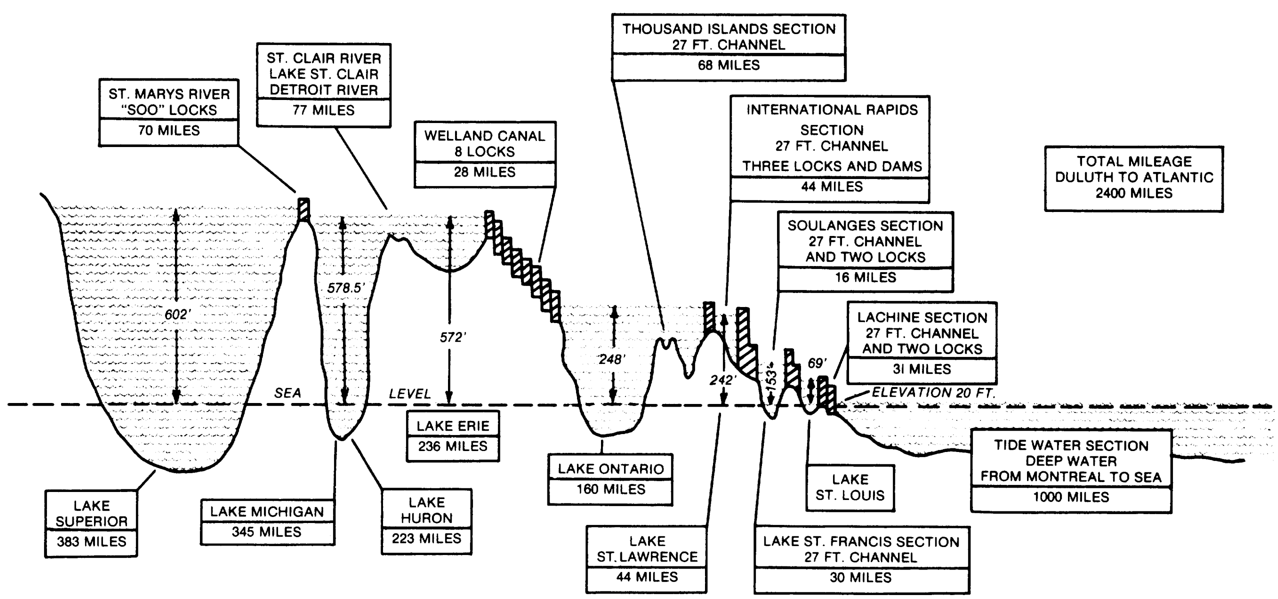



**Figure IX.7. Profile of the Great Lakes—St. Lawrence Seaway.**

the facilities and services provided. This is the only U.S. waterway where such user charges are assessed at the present time.

The Canadian Government maintains a minimum channel depth of 35 feet from Montreal to the Atlantic Ocean. From Montreal to the Lakehead, a minimum channel depth of 27 feet is maintained in restricted channels and canals connecting the open waters of the five Great Lakes.

The Great Lakes are open to navigation for approximately 9 months of the year; ice closes the St. Lawrence Seaway from early January until early April. Both Canadian and United States Coast Guard icebreakers are used to assist shipping at the beginning and end of each shipping season.

***Future Physical Waterways.*** The evolution of the Great Lakes-St. Lawrence waterway from a state of nature to its present configuration can be broadly traced through the interaction of the demands of an ever-burgeoning commerce on the physical constraints of the system and the fleet that serves it. The interactive forces at work are not, however, readily subject to simplistic explanation.

Since the future development process could follow divergent paths, the analysis of estimated 1980 and 1990 system impacts and requirements has been limited to the "most likely case."

No major expansions to be completed by 1990 are presently planned or authorized for the Great Lakes-St. Lawrence Seaway system. Extension of the navigation season from its present 9- to 10-month period to a longer period is, however, under consideration by Canadian and United States authorities, and new icebreaking techniques are being evaluated. Year-round navigation on the Upper Great Lakes is likely before 1985.

***Great Lakes Fleet.*** Two distinct fleets ply the Great Lakes-St. Lawrence Seaway system trade route. The domestic or "laker" fleet, comprised of uniquely designed vessels of U.S. and Canadian registry, operates entirely within the system and is dedicated to carrying dry- and liquid-bulk commodities. The ocean fleet is essentially the world fleet or, more specifically, that portion of the world fleet that can be accommodated by the dimensions of the St. Lawrence and Welland Locks.

*Domestic Fleet Today.* The Great Lakes-St. Lawrence Seaway system domestic fleet consists principally of three types of self-propelled vessels as shown in table IX.12.

The capacity of ships is usually expressed in deadweight tons (DWT) (long-tons = 2,240 pounds), defined as the total carrying capacity of a vessel, including cargo, fuel oil, fresh water, stores, crew, etc. It is equal to the difference between a vessel's loaded and lightweight displacement.

**Table IX.12**
**Principal Commercial Elements, Domestic Fleet in 1975**

| Vessel Type | Number | Trip Capacity (long tons) |
|---|---|---|
| Dry Bulk Freighter | 208 | 3,196,000 |
| Self-Unloaders | 79 | 1,469,000 |
| Tankers | 58 | 329,000 |
| Total | 345 | 4,994,000 |

*Source: Greenwood's Guide to Great Lakes Shipping, 1975.*

Dry-bulk carriers as a class, including self-unloaders, clearly constitute the most significant fleet element in terms of numbers and trip capacity. They are primarily employed in the iron ore, grain, coal, and limestone trades, although a number of the smaller vessels operate in specialty bulk trades carrying commodities such as cement and sugar.

The self-unloading ship, cited as a very recent innovation in ocean shipping, was introduced on the Great Lakes 50 years ago. It is a special type of vessel within the dry-bulk class and is, essentially, an adaptation of the unique Great Lakes bulk-carrier design. Fitted with shipboard unloading systems, the largest and newest of these vessels are capable of discharging cargo at rates up to 11,000 tons per hour. The flexibility and fast port turnaround time provided by self-unloading systems have made them increasingly attractive as dry-bulk vessels increase in size and trip capacity.

Table IX.13 displays the 1975 distribution of the combined U.S. and Canadian dry-bulk fleet in terms of size and capacity. U.S. vessels represent 59 percent of the fleet and account for over 57 percent of total capacity. Vessels 600 feet and longer make up 86 percent of fleet capacity; the distribution has a second peak at the 700- to 730-foot class.

**Table IX.13**
**1975 Dry Bulk Lake Freighters**
(U.S. and Canadian registry)

| Vessel Length (Feet) | No. Ships | % Total Ships | Capacity Long Tons | % Total Capacity | Avg. Capacity |
|---|---|---|---|---|---|
| Under 400 | 35 | 12.2 | 115,960 | 2.5 | 3,313 |
| 400-499 | 9 | 3.1 | 73,240 | 1.6 | 8,137 |
| 500-549 | 9 | 3.1 | 94,850 | 2.0 | 10,539 |
| 550-599 | 32 | 11.1 | 375,025 | 8.0 | 11,719 |
| 600-649 | 110 | 38.3 | 1,690,450 | 36.2 | 15,367 |
| 650-699 | 24 | 8.4 | 505,610 | 10.8 | 21,067 |
| 700-730 | 56 | 19.5 | 1,401,825 | 30.1 | 25,032 |
| 731-849 | 9 | 3.1 | 247,525 | 5.3 | 27,503 |
| 850-949 | 1 | 0.3 | 44,500 | 1.0 | 44,500 |
| 950-over | 2 | 0.7 | 115,500 | 2.5 | 57,750 |
| Totals | 287 | 99.9 | 4,664,485 | 100.0 | |

*Source: Greenwood's Guide to Great Lakes Shipping, 1975.*

Capacity concentration in vessels over 600 feet evolved as vessel size mix shifted in response to the stimulation of increasing demand and construction of locks with larger dimensions. The second peak of the distribution reflects a part of this shift. Vessels in the 700- to 730-foot class, built to optimize the dimensions of the Welland and St. Lawrence locks, are primarily of Canadian registry and entered service in the 1960's following the opening of the St. Lawrence Seaway in 1959. These vessels replaced a fleet of 258 vessels termed "canallers" which were 250 feet long with an average capacity of 2,230 tons (see fig. IX.8). Within 5 years of the opening of the seaway and with little public awareness, there occurred one of the largest examples of bloc obsolescence of shipping in maritime history as uneconomic canallers moved to the scrapyard. The shift in vessel size mix toward larger, more economic vessels is continuing. With the building of an enlarged Poe Lock at the "Soo," the 1,000-foot dry-bulk carrier of about 60,000 long-tons capacity has emerged. At the end of 1975, two of these vessels were in service and eight more were on order.

Despite the bloc obsolescence and replacement noted above, the Great Lakes dry-bulk fleet is considered ancient in terms of maritime standards of useful vessel life. The average vessel age of the fleet is about 35 years, whereas the maritime standard is closer to 20–25 years. On the basis of activity and capacity, however, the age distribution of the Great Lakes fleet is not nearly so bleak; the average age weighted by travel frequency and capacity is about 27 years. Variance from the maritime standard is due in part to the freshwater marine environment of the lakes, which is physically less harsh on shipping than seawater. Perhaps more importantly, particularly for the U.S. segment of the fleet, economic life has been extended through operation of U.S. and Canadian cabotage laws, which insulate the fleet from the rigors of competition for carriage of domestic traffic. Only traffic between the United States and Canada falls entirely in the competitive arena and its carriage is largely dominated by newer, more economically efficient Canadian vessels.

Table IX.14 displays the capacity distribution of the 1975 dry-bulk fleet in terms of age and vessel size class. A significant proportion of fleet capacity is generally acknowledged by industry to be obsolete and in need of replacement. Fleet trip capacity needed to meet projected 1980 and 1990 lift requirements will of necessity, therefore, require new building for replacement as well as for capacity expansion.

**Table IX.14**
**1975 Dry Bulk Fleet by Vessel Length and Age**

| | Age (Years) | | | | | | |
|---|---|---|---|---|---|---|---|
| Length in Feet | 55 and over | 45 54 | 35 44 | 25 34 | 15 24 | 5 14 | under 5 |
| | | | Percent of Capacity | | | | |
| Under 400 | 0.1 | 0.4 | – | 0.04 | 1.0 | 0.6 | 0.1 |
| 400-499 | 0.4 | 0.1 | – | 0.1 | – | 0.5 | – |
| 500-549 | 1.9 | – | – | – | – | 0.2 | – |
| 550-599 | 4.8 | 1.8 | – | – | 0.5 | 0.2 | – |
| 600-649 | 9.4 | 7.8 | 1.2 | 8.3 | 5.7 | 1.9 | 1.7 |
| 650-699 | 0.6 | – | 0.6 | – | 0.8 | 0.4 | 1.7 |
| 700-730 | – | – | – | – | 6.6 | 21.1 | 2.5 |
| 731-849 | – | – | – | – | 4.2 | 0.5 | – |
| 850-949 | – | – | – | – | – | – | 0.9 |
| 950-Over | – | – | – | – | – | – | 2.4 |
| Total Fleet | 16.6 | 10.7 | 1.2 | 8.84 | 26.0 | 25.4 | 9.3 |

*Ocean Fleet.* The ocean fleet, of predominantly foreign registry, operates on international trade routes serving Great Lakes ports for carriage of bulk and general cargoes, including containerized commodities. A portion of the ocean fleet provides scheduled liner service and is primarily dedicated to general cargo trade. The largest portion of the ocean fleet (approximately 70 percent), however, consists of vessels engaged in the tramp trades, carrying grain, other bulk cargoes, and shipload lots of relatively low-value iron and steel general cargo. Fleet numbers and nationality vary from year to year with the volume of export grain and

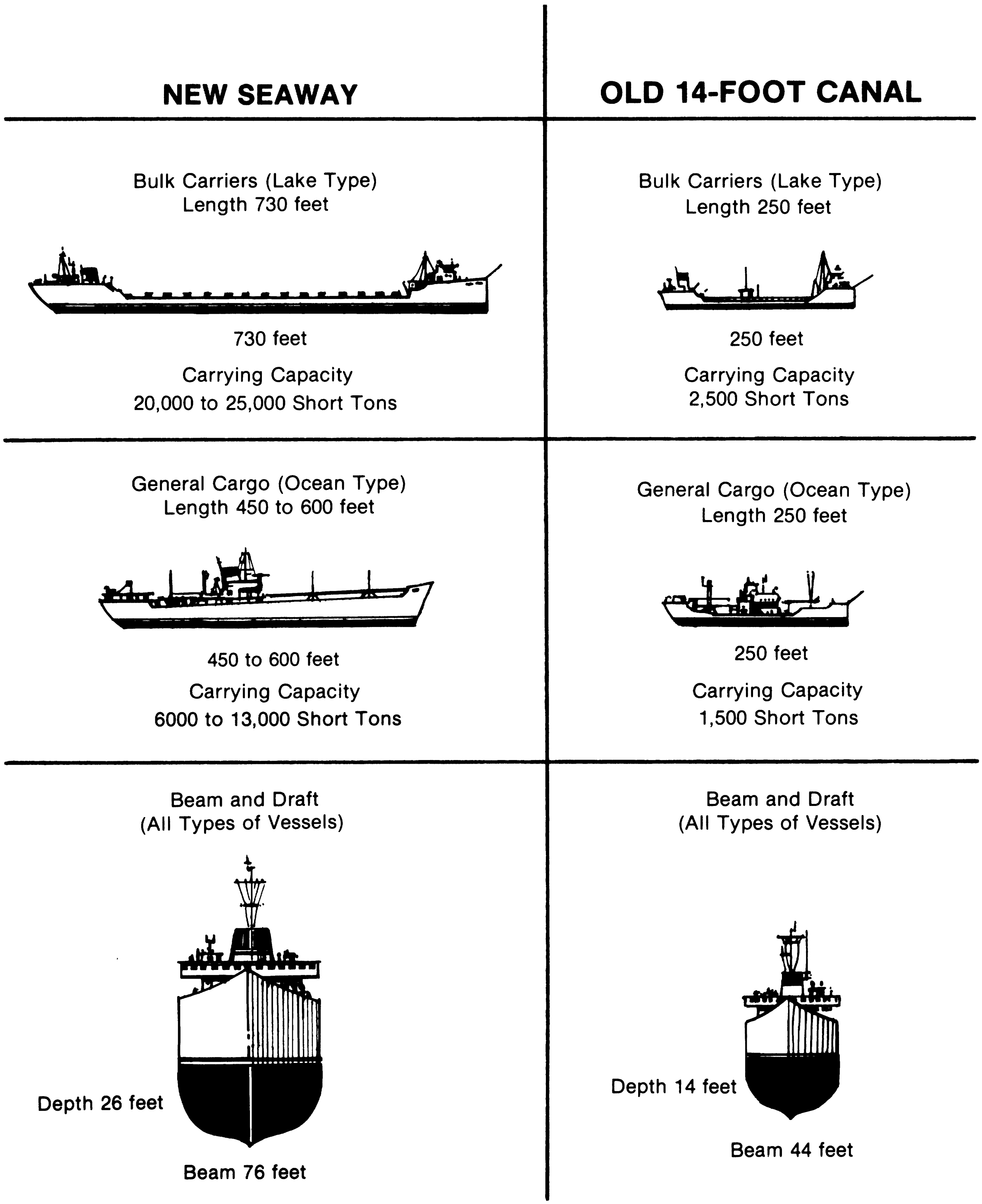



**Figure IX.8. Limitations of Vessel Sizes for the St. Lawrence Seaway Compared with the Old Canal.**

the random opportunities for employment offered by the world charter market. Lock size constraints limit system access to vessels of 76-foot beam, 730-foot length, and maximum loaded draft of 26 feet.

The beam constraint is the most severe limitation to ocean vessel access; the ocean marine environment requires vessels designed with a beam-to-length ratio greater than that required for Great Lakes vessels. As a result ocean vessels generally cannot optimize the 730-foot length of the locks. Moreover, compared with lake vessels of similar dimensions, ocean vessel cargo capacity is less. Design capacity is determined by the streamlining of the immersed portion of the hull required by wave characteristics; Great Lakes and ocean wave characteristics vary substantially. The flat bottom and blunt bow and stern of the typical lake-design vessel enables it to carry more cargo.

Draft constraint does not physically prevent most of the world fleet from entering the system, but does limit a majority of the fleet from carrying a full design capacity load when employed in the Great Lakes. The draft constraint therefore becomes more a question of competitive routing economics for a particular haul, given that the vessel operator expects to receive the equivalent revenue of a full load.

The economic aspect of draft constraint is most severe for shipment of bulk commodities. The problem is significantly mitigated, however, by topping off the lakes load at lower St. Lawrence ports, east of Montreal, with tonnage previously moved to those ports by lake vessels. General cargo vessels are affected to a far lesser extent; vessels in general cargo trade normally reach cubic capacity limits before maximizing design draft and, due largely to the service requirements of the trade, operate at load factors ranging from 55 to 80 percent.

On the basis of 1974 vessel dimensions, an estimated 90 percent of the breakbulk general cargo ships in the world fleet were physically capable of entering the Great Lakes system.

*Future Domestic Fleet.* Given the estimated number of trips the fleet can make during a 275-day navigation season, the projected 1980 and 1990 tonnage flows, and the assumption that existing capacity is scrapped at age 55, capacity requirements have been derived and are displayed in table IX.15 together with estimated investment needs in constant 1975 dollars.

**Table IX.15**
**Estimated Dry Bulk Fleet Requirements**

| Capacity | 1975-1980 | 1980-1990 | 1975-1990 |
|---|---|---|---|
| | Long tons | | |
| Estimated Capacity Required | 4,902,000 | 6,148,000 | 6,148,000 |
| Less Beginning Capacity | 4,665,000 | 4,902,000[1] | 4,665,000 |
| New Capacity Required | 237,000 | 1,246,000 | 1,483,000 |
| Add Replacement | 768,000 | 550,000 | 1,318,000 |
| Total New Building Required | 1,005,000 | 1,796,000 | 2,280,000 |
| | Millions of dollars | | |
| Estimated Investment New Building | 663.3[2] | 1,185.3[2] | 1,848.6[2] |

[1]*Assumes capacity additions and replacements in service by 1980.*
[2]*Maritime Administration.*

New building for capacity expansion and replacement is expected to be confined almost entirely to vessels exceeding 600 feet in length. Further, it is anticipated that all new additions to the fleet will be self-unloaders; in the United States no "straight-deckers" have been built since 1961, and in Canada there has not been a large straight-deck bulk freighter built since 1969. The dramatic increase in pelletized iron ore cargoes in recent years is largely responsible for this concentration in self-unloader building. Formerly, the physical characteristics of iron ore prevented it from being handled efficiently by the belt conveyor systems of the self-unloading vessel. Pellets are well adapted to such systems, however, and since 90 percent of the iron ore movement will soon be pelletized, dry-bulk vessel operators can be expected to increasingly exploit the inherent economies of the self-unloading system.

The composition of the 1990 dry-bulk fleet has been projected on the basis of the various trade flows and is displayed in table IX.16.

**Table IX.16**
**Estimated Dry Bulk Fleet — 1990**

| Vessel Length (Feet) | No. Ships | % Total Ships | Capacity (Long Tons) | % Total Capacity |
|---|---|---|---|---|
| Under 400 | 28 | 10.2 | 92,764 | 1.5 |
| 400-499 | 6 | 2.1 | 48,822 | 0.1 |
| 500-549 | 1 | 0.3 | 10,539 | 0.1 |
| 550-599 | 6 | 2.1 | 70,314 | 1.1 |
| 600-649 | 54 | 19.7 | 829,818 | 13.4 |
| 650-699 | 34 | 12.4 | 716,278 | 11.6 |
| 700-730 | 106 | 38.6 | 2,653,392 | 43.1 |
| 731-849 | 12 | 4.3 | 330,036 | 5.3 |
| 850-948 | 12 | 4.3 | 534,000 | 8.6 |
| 950-Over | 15 | 5.4 | 866,250 | 14.0 |
| Total | 274 | 100.0 | 6,152,213 | 100.0 |

Compared with the 1975 fleet, the 1990 fleet is projected to decline 4.5 percent in terms of vessel numbers while fleet trip capacity is projected to increase 31.8 percent. The shift to larger, more economic vessels is apparent; 96 percent of trip capacity is concentrated in vessels exceeding 600 feet and 71 percent in vessels 700 feet and longer. Substantial operating efficiencies accompany the shift in vessel size mix, as shown by the range of significant performance measures in table IX.17 derived from a fleet simulation model.

**Table IX.17**
**Selected Performance Measures[1]**

| | Vessel Length | |
|---|---|---|
| | 640 feet | 1,000 feet |
| Ton-Mile Revenue (mils) | 3.68 | 3.27 |
| Ton-Mile Op. Cost (mils) | 2.04 | 1.22 |
| Energy Efficiency (ton-miles/gallons) | 437 | 527 |

[1]*Revenue per ton-mile based on required freight rate calculation, that includes capital costs, interest, and a net after taxes of 10%. Round trip costs are reflected in the performance measures, including empty backhaul and port time. Energy efficiency based on total fuel consumption for trip loaded in one direction and ballast return.*

The shift in vessel size mix toward the 1990 projection is progressing, as evidenced by the contracted new building on order at the end of 1975 shown in table IX.18.

**Table IX.18**
**Dry Bulk Freighters on Order in 1975**

| Vessel Length (Feet) | No. Ships | Capacity (Long Tons) | Year in Commission |
|---|---|---|---|
| Under 400 | 1 | 4,000 | 1976 |
| 700-730 | 5 | 126,000 | 1976 (4)<br>1977 (1) |
| 731-849 | 1 | 28,000 | 1976 |
| 950-Over | 8 | 462,000 | 1976 (1)<br>1977 (3)<br>1978 (2)<br>1979 (2) |

*Source:* Annual Report, *Lake Carriers Association, 1975.*

***Great Lakes — St. Lawrence Seaway Freight Today.*** The growth of Great Lakes-St. Lawrence Seaway traffic relative to the expansion of total U.S. waterway traffic in the 1963–73 decade can be deduced from U.S. Army Corps of Engineers waterborne commerce statistics. The corps statistics as published, however, do not permit a ready comparison; Corps statistics *include* inland movement of foreign trade tonnage as domestic traffic on the rivers, but *exclude* such tonnage from Great Lakes-St. Lawrence Seaway System domestic traffic tabulation. To compare traffic densities on waterway right-of-way, Great Lakes-St. Lawrence Seaway system foreign and domestic tonnages have been combined in table IX.19.

**Table IX.19**
**Tonnage and Percent Change**
**Inland Waterway and Great Lakes**
**1963 — 1973**
(000 short tons)

| Waterway | Tons 1963 | Tons 1973 | Percent Change |
|---|---|---|---|
| Great Lakes | 209,513 | 231,902 | + 10.6 |
| Inland Waterway | 578,595 | 762,256 | + 31.7 |
| Total | 788,108 | 994,158 | + 26.1 |

Clearly, Great Lakes-St. Lawrence Seaway system traffic has increased only moderately, compared with traffic growth on the inland river and coastal waterway systems. Relatively slower Great Lakes-St. Lawrence Seaway system traffic growth is in part due to a different commodity mix and in part to the impact of technological change in both the steelmaking and iron ore industries. Table IX.20, for example, highlights the nonparticipation of the Great Lakes-St. Lawrence Seaway system in the growing transportation market for petroleum and reveals the heavy concentration of Great Lakes traffic in iron ore and limestone raw materials feeding the steel industry.

**Table IX.20**
**Principal Commodities in**
**Waterborne Commerce, 1973**

| Commodity | Inland % | Great Lakes % |
|---|---|---|
| Petroleum | 52.4 | 4.4 |
| Coal and coke | 13.5 | 17.2 |
| Iron ore | 0.0 | 42.4 |
| Stone, sand, gravel | 9.5 | 18.9 |
| Grains | 1.5 | 6.5 |
| Chemicals | 5.4 | 0.6 |
| All Other | 17.7 | 10.0 |
| Total | 100.0 | 100.0 |

Over the 1963–73 decade, technological changes in the production of both pig iron and iron ore combined to reduce transportation requirements for raw materials used in the steelmaking process. On the basis of the raw material inputs per ton of pig iron, the shift from the open-hearth furnace to the basic oxygen process at once increased the iron ore requirement and reduced by 18.5 percent the limestone requirement. On the other hand, increasing adoption of the electric-furnace method of pig iron production reduced total demand for ore through substitution of scrap. An indication of the dimensions of these shifts can be discerned in table IX.21.

**Table IX.21**
**U.S. Steel Production**
**1963, 1973, 1975**

| Furnace | Percent by Furnace Type 1963 | 1973 | 1975 |
|---|---|---|---|
| Open hearth | 81.3 | 26.3 | 18.9 |
| Bessemer | 0.8 | – | – |
| Basic oxygen | 7.8 | 55.2 | 61.5 |
| Electric | 9.9 | 18.3 | 19.4 |

*Source: American Iron and Steel Institute.*

The form in which iron ore is transported also changed significantly over the 1963–73 period. Upgrading of raw ore through benefication and pelletizing increased the iron content per ton of ore shipped from about 54 percent in 1963 to 61 percent in 1973, thus reducing the lift requirement, or transportation demand, by approximately 13 percent. The Bureau of Mines predicts a continuation of this upgrading process and estimates that the iron content per ton of ore will approximate 70 percent in 1985 and 80 percent by the year 2,000.

***Future Great Lakes-St. Lawrence Seaway Freight.*** Contrasting with the near stabilization of the U.S. Great Lakes-St. Lawrence Seaway system domestic trade (1.2 percent compound annual growth rate over the decade), U.S. traffic with Canada and overseas points increased substantially during the 1963–73 period. U.S.-Canadian traffic, including iron ore imports, increased 26 percent and overseas trade by 176 percent. This trend of faster growth for the Canadian and overseas segments of U.S. traffic is expected to continue through the 1975–90 period.

Impacting demand for Great Lakes-St. Lawrence Seaway system transportation includes Canadian as well as U.S. traffic. The three major traffic components are :

- U.S. domestic and overseas trade;
- Canadian domestic and overseas trade;
- U.S.-Canadian trade.

To evaluate fleet and right-of-way requirements for the 1975–90 period, each of the traffic components was estimated. Projections of U.S. domestic traffic, trade with Canada, and U.S. overseas trade were derived from studies completed by the U.S. Department of Commerce.[4] Canadian domestic and overseas projections were furnished by the Canadian St. Lawrence Seaway Authority.[5] Table IX.22 displays the projections in consolidated form. The table also displays the estimated ton-mile demand for traffic passing through U.S. ports *only* and is a measure of the ton-miles of U.S. cargo carried *within* the system, i.e., excluding movement east of Montreal. Since meridian 74 west passes through both Montreal and New York City, Montreal is the equivalent of the U.S. seaboard for comparison and performance measurement.

Table IX.23 displays the projections of table IX.22 in terms of percent change over the 1975–90 period and more clearly reflects the growth assumptions of the underlying source documents. Clearly, domestic traffic is expected to break sharply with the slow growth trend of the past decade while U.S.-Canadian and foreign trade continue to grow substantially, albeit with slower momentum. The projected demand for Great Lakes-St. Lawrence Seaway system transportation, if realized, may be expected to place significantly greater stress on system elements and resources.

## Domestic Ocean Trade

***Physical Waterways Today.*** Most of the major shipping ports on the North American continent are located in the United States. Access to U.S. ports is generally limited only by channel and harbor depths, which are maintained by the Army Corps of Engineers. The slope and shallow depth of the Continental Shelf off the East and Gulf Coasts is also an

[4]U.S. Department of Commerce, Maritime Administration, *Domestic Waterborne Shipping Analysis*, February 1974.

[5]The St. Lawrence Seaway Authority, *Cargo Movements in the St. Lawrence Seaway: A Traffic Demand Study for 1980, 1985, and 1990*, December 1975.

**Table IX.22**
**Projected Trade Flows**
**Great Lakes–St. Lawrence Seaway Systems**
(000 short tons)

| Commodity | 1975 | 1980 | 1990 |
|---|---|---|---|
| | **U.S. Domestic Trade** | | |
| Iron ore | 85,395 | 93,136 | 116,721 |
| Coal | 47,534 | 47,815 | 59,001 |
| Limestone and mine products | 39,103 | 42,507 | 51,993 |
| Domestic grain | 2,504 | 2,809 | 3,488 |
| Other | 19,614 | 22,806 | 30,589 |
| Subtotal | 194,150 | 209,073 | 261,792 |
| | **U.S. Foreign Trade** | | |
| **Imports** | | | |
| Iron ore | 16,573 | 21,829 | 24,527 |
| Steel | 3,662 | 5,737 | 9,892 |
| Other | 8,415 | 13,040 | 22,052 |
| **Exports** | | | |
| Coal | 18,141 | 22,140 | 33,132 |
| Grain | 12,656 | 18,000 | 25,000 |
| Other | 7,986 | 11,059 | 17,644 |
| Subtotal | 67,433 | 91,805 | 132,247 |
| Total U.S. | 261,583 | 300,878 | 394,039 |
| | **Canadian Trade** | | |
| Grain | 17,800 | 19,800 | 23,000 |
| Iron ore | 6,300 | 7,600 | 10,300 |
| Other | 17,000 | 18,900 | 28,600 |
| Total Canada | 41,100 | 46,300 | 61,900 |
| Total U.S. and Canada | 302,683 | 347,178 | 455,939 |
| U.S. Ton-miles Within System (billions) | 132 | 159 | 211 |

**Table IX.23**
**Percent of Change in Projected Trade Flows for Great Lakes–St. Lawrence Seaway Systems**

| | 1975-1980 | 1980-1990 | 1975-1990 |
|---|---|---|---|
| Iron ore | 9.0 | 25.3 | 36.6 |
| Coal | 0.5 | 23.3 | 24.1 |
| Limestone and mine products | 8.7 | 22.3 | 32.9 |
| Domestic grain | 12.1 | 24.1 | 39.2 |
| Other | 16.2 | 34.1 | 55.9 |
| U.S. Domestic | 7.6 | 25.2 | 34.8 |
| U.S. Foreign trade | 36.1 | 44.0 | 96.1 |
| Total U.S. | 15.0 | 30.9 | 50.6 |
| Total U.S. and Canada | 14.7 | 31.3 | 50.6 |
| U.S. Ton-miles within system | 20.0 | 33.1 | 59.8 |

inhibiting factor. There are approximately 149 ports and harbor areas with a controlling depth of 25 or more feet. Some 35 of these port areas have depths of 40 or more feet. With few exceptions, the largest fully loaded vessel that can navigate East and Gulf Coast ports is a 65,000-deadweight-ton tanker. Lightening of deeper draft vessels allows them to enter port once sufficient cargo has been removed to allow safe bottom clearance. Pacific Coast ports in Puget Sound, Washington, and Long Beach, California, can handle 120,000-deadweight-ton vessels or larger owing to their deeper port depths.

Except for some ports in Alaska, all U.S. seaports are generally navigable year round.

***Future Physical Waterways.*** No major changes are forecast for the physical waters in ports and harbor approaches between now and 1990. Widening and deepening of coastal ports and of harbor channel dimensions will be limited due to a number of considerations, not the least of which are the high cost of such projects and serious environmental concerns.

Port facilities will continue to expand where land and funding is available. The trend toward specialized facilities for container ships, Roll on/Roll off vessels (Ro-Ro), Barge-on-Ship vessels (LASH and SEABEE), liquefied gas carriers (LNG and LPG), and both dry-bulk and liquid-bulk ships will undoubtedly continue.

Interport competition is not likely to diminish, and excess capacity, particularly container facilities, will grow. Intermodal interface with truck and rail will grow, particularly in contiguous coastal ports.

With the exception of Puget Sound, no U.S. port area will be accessible to fully loaded superships: very large crude carriers (VLCC)—140,000 deadweight tons—and ultra large crude carriers (ULCC)—300,000 or more deadweight tons.

A "new" domestic trade route will be established between Valdez, Alaska, and West Coast ports for transport of oil from the southern terminus of the Trans-Alaskan Pipeline System (TAPS) to refineries in the lower 48 States.

Offshore oil terminals are expected to be built in the Gulf of Mexico. These terminals will have the capability of handling the largest tankers now afloat (540,000 deadweight tons, 90-foot draft). Table IX.24 lists the relevant details of two of these projects. It should be noted that these offshore terminals will be used primarily for receipt of foreign oil for transshipment by pipeline ashore. The maximum combined capacity of these terminals may be as high as 7.5 million barrels per day (1 million tons per day).

When operating at peak capacity, diversion of some tanker traffic from East Coast ports may occur.

**Table IX.24**
**Manned Offshore Oil Terminals**
**In the Gulf of Mexico**

| TERMINAL DATA | | LOOP | SEADOCK |
|---|---|---|---|
| Shore terminus | | Grand Isle, Louisiana | Freeport, Texas |
| Shoreside storage capacity | | 56 million barrels | 22.5 million barrels |
| Offshore platform complex | | 18.0 miles offshore | 26 miles offshore |
| Number of single point moorings (SPM) | | 6 | 4 |
| Number and size of pipelines to shore | | 3-48" buried in seabed | 3-52" buried in seabed |
| Nominal capacity | | 1.4 million barrels/day | 2.5 million barrels/day |
| Peak capacity | | 3.4 million barrels/day | 4.0 million barrels/day |
| Phase I: | Cost | $388 million | $659 million |
| | Completion | 1980 | 1980 |
| | Capacity | 1.4 million barrels/day | 2.5 million barrels/day |
| Phase II: | Cost | $182 million | $206 million |
| | Completion | 1981 | Not specified |
| | Capacity | Not Specified | 4.0 million barrels/day |
| Phase III: | Cost | $268 million | Project Completed in Phase II |
| | Completion | 1989 | |
| | Capacity | 3.4 million barrels/day | |

*Source: U.S. Coast Guard.*

***U.S. Oceangoing Fleet Today.*** The U.S. flag oceangoing fleet is, of course, used in both the domestic and foreign trade. A detailed discussion of the fleet is included in chapter XV: International Marine Transportation.

Approximately 38 percent (205) of the 543 active U.S.-flag vessels of over 1,000 deadweight tons are used exclusively in the domestic ocean trade. Domestic ocean trade between U.S. ports, except to the Virgin Islands, is carried, exclusively by law (Jones Act), in U.S. flag ships. Table IX.25 shows the domestic ocean fleet as of June 1975.

**Table IX.25**
**June 1975 U.S. Flag Domestic Oceangoing Fleet**
(Tonnage in thousands of long tons)

| | Total | | Combination Passenger/Cargo | | Freighters | | Tankers | |
|---|---|---|---|---|---|---|---|---|
| **Trade** | **No.** | **DWT** | **No.** | **DWT** | **No.** | **DWT** | **No.** | **DWT** |
| Coastal | 153 | 4,653 | – | – | 17 | 354 | 136 | 4,299 |
| Intercoastal | 11 | 271 | – | – | 3 | 54 | 8 | 217 |
| Noncontiguous | 41 | 763 | 1 | 7 | 28 | 417 | 12 | 339 |
| Total | 205 | 5,687 | 1 | 7 | 48 | 825 | 156 | 4,855 |

*Source: Maritime Administration* Annual Report — 1975.

Over 75 percent of this domestic fleet consists of tankers used in coastwise movement of petroleum products.

The coastal ports are the major intermodal links of the Country with all modes represented in many port areas. Growth of the container trade continues and has played a significant role in the development of intermodal facilities and equipment. Table IX.26 lists the intermodal equipment of U.S.-flag marine carriers and the major leasing companies for the years 1973 to 1975 and shows the recent rapid growth particularly in containers and LASH barges, which are both used in domestic and foreign trade.

**Table IX.26**
**U.S. Intermodal Equipment Survey**

| Category | 1973 | 1974 | 1975 |
|---|---|---|---|
| Vessels | | | |
| Containership | 98 | 95 | 97 |
| Partial Containership | 59 | 60 | 53 |
| LASH | 14 | 20 | 20 |
| LASH Feeder | 0 | 3 | 4 |
| SEABEE | 3 | 3 | 3 |
| RO/RO (Roll on/Roll off) | 5 | 6 | 6 |
| Combination Container/ RO/RO | 4 | 4 | 4 |
| Cargo Vehicles | | | |
| Containers | 366,033 | 441,854 | 471,675 |
| Chassis | 112,304 | 121,104 | 124,476 |
| LASH Barges | 1,808 | 2,961 | 3,110 |
| SEABEE Barges | 246 | 246 | 246 |
| RO/RO Trailers | 2,239 | 2,236 | 2,826 |

*Source: Maritime Administration.*

The Uniform Intermodal Interchange Agreement (UIAA) which was finalized in May 1973, promulgates rules under which water, rail, and highway carriers interchange containers in the United States. The long-range impact of this agreement is seen as hastening and improving intermodalism.

A significant number of tug/barge operations take place in all coastal ports, not only for local transportation of cargoes but also for movements along the coasts and to noncontiguous States and territories.

The average line-haul cost per ton-mile in the domestic ocean trade varies considerably with type of vessel and length of haul. Costs in 1976 ranged from about 1 to 5 mils per ton-mile. The list below shows, in ascending order, the comparative line-haul cost ranking of a number of different types of vessels engaged in domestic ocean trade:

- Integrated tug/barge (tanker)
- Tanker
- Victory class ship (breakbulk)
- C-3 class ship (breakbulk)
- C-4 class ship (breakbulk)
- C-2 class ship (breakbulk)
- C-1 class ship (breakbulk)
- Roll-on Roll-off (Ro-Ro) ship
- Fully containerized ship (1,300 containers)
- Fully containerized ship (510 containers)
- Integrated tug/barge (container carrier)
- Lighter aboard ship (LASH) barge carrier
- Tug/barge (large hawser)
- Tug/barge (small hawser)

***Future U.S. Oceangoing Fleet.*** Present harbor and harbor entrance depths and the Continental Shelf will continue to influence ship sizes. The projected size of the U.S. domestic ocean fleet will obviously be dictated largely by the projected domestic ocean trade through 1990, which shows a tremendous increase in the coastwise movement of petroleum products.

The transportation of oil from the southern end of the Trans-Alaskan Pipeline System (TAPS), for example, will require a fleet of 35 modern tankers, most of which have yet to be built. Table IX.27 lists the vessels that will be operating on this route between Valdez, Alaska, and West Coast ports.

The Maritime Administration estimates that approximately 25 U.S.-flag tankers of 30,000 DWT could be employed in the movement of petroleum products between the Virgin Islands and the mainland. This number could be significantly increased if the Virgin Islands exemption from the cabotage laws is rescinded.

***Domestic Ocean Trade Today.*** United States trade at seaports consists of both foreign and domestic traffic. As indicated in figure IX.9, foreign trade has been growing at a much greater rate than domestic ocean trade. (Chapter XV discusses foreign trade.) Domestic ocean trade since World War II has increased from 153.1 to 233.4 million tons or 52.4 percent in the 27-year period ending in 1974.

**Table IX.27**
**Tankers to be Operated in TAPS Transportation**
(Tonnage in thousands of long tons)

| | Number | Deadweight Tonnage |
|---|---|---|
| | 1 | 45 |
| | 3 | 60 |
| | 2 | 70 |
| | 3 | 75 |
| | 2 | 80 |
| | 2 | 90 |
| | 16 | 120 |
| | 5 | 130 |
| | 1 | 150 |
| Total | 35 | 3,650 |

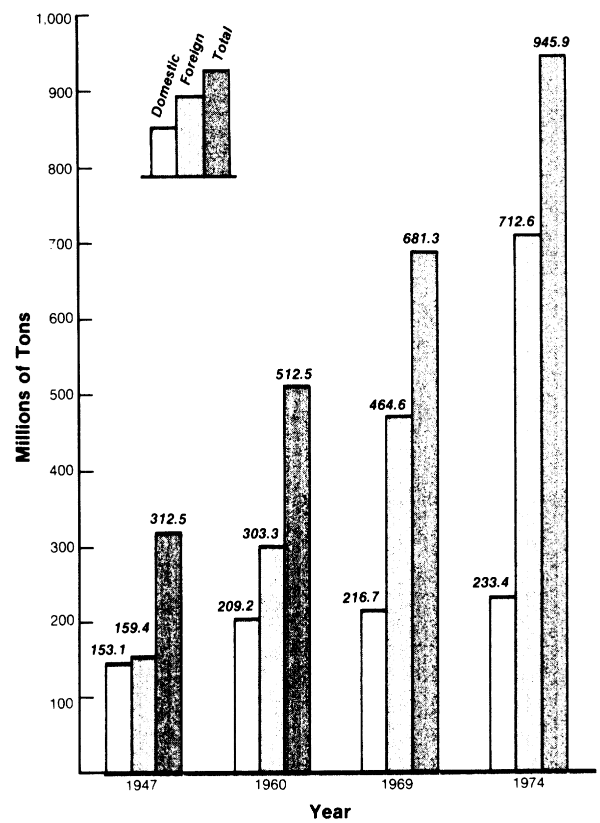



**Figure IX.9. Comparison of Foreign Trade with Domestic Trade Through Coastal Ports.**

Domestic ocean trade can be separated into two distinct categories:

- *Contiguous*—This trade includes all trade along, to, and from the Atlantic, Pacific, and Gulf Coasts;
- *Noncontiguous*—Domestic trade with Hawaii, Alaska, Puerto Rico, and the Virgin Islands.

Table IX.28 provides a summary of the overall tonnage in domestic ocean trade in 1974. As with other segments of waterborne commerce, the transportation of oil dominates domestic ocean trade. Over 75 percent of domestic ocean trade is carried in self-propelled vessels.

Table IX.29 shows the breakdown of shipments and receipts in domestic ocean trade at nine contiguous and noncontiguous regions, and table IX.30 summarizes this trade for 1974.

*Future Domestic Ocean Trade.* Domestic ocean trade is expected to increase at a greater rate through 1990 than trade on the inland waterways and the Great Lakes. Forecasts of domestic ocean trade by commodity groups are shown in table IX.31. The high growth rate results from anticipated increases in petroleum and petroleum product shipments, particularly within the North Atlantic region. The average haul of cargo in domestic ocean trade will be substantially reduced because of these increased intraregional flows.

**Table IX.28**
**Summary of Overall Tonnage Carried In Domestic Ocean Trade for 1974[1]**
(Thousands of short tons, figures and totals rounded)

| Trade Area | Nonpetroleum | | Petroleum | | Dry Cargo | | Total Tonnage | Percent Carried by Self-propelled Vessels |
|---|---|---|---|---|---|---|---|---|
| | Self-propelled Vessel | Barge | Self-propelled Vessel | Barge | Self-propelled Vessel | Barge | | |
| Coastal | 8,324.8 | 3,155.7 | 106,746.8 | 31,129.0 | 4,735.9 | 19,585.5 | 173,677.8 | 68.99 |
| Noncontiguous | 2,342.6 | 507.6 | 38,976.2 | 816.5 | 9,983.2 | 2,588.1 | 55,214.1 | 92.91 |
| Intercoastal | 779.8 | 0 | 1,492.3 | 0 | 2,009.1 | 158.6 | 4,439.8 | 96.43 |
| Total | 11,447.2 | 3,663.3 | 147,215.4 | 31,945.5 | 16,728.2 | 22,332.2 | 233,331.8 | 75.16 |
| Percent of total | 4.91 | 1.58 | 63.09 | 13.69 | 7.16 | 9.57 | 100 | – |

[1]*Does not include trade between Puerto Rico, the Virgin Islands, and U.S. ports.*

**Table IX.29**
**Domestic Ocean Trade In 1974**
(Thousands of short tons)

| | Receipts At | SHIPMENTS FROM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Contiguous | | | | | Noncontiguous | | | |
| | | North Atlantic | South Atlantic | Gulf | California | Pacific Northwest | Alaska | Hawaii | Puerto Rico | Virgin Islands |
| Contiguous | North Atlantic | 45,783.3 | 1,586,9 | 46,163.9 | 685.7 | 525.9 | 0 | 0 | 4,981.5 | 19,000.5 |
| | South Atlantic | 2,238.5 | 239.4 | 15,073.0 | (1) | 46.2 | 0 | 0 | 1,556.8 | 1,955.6 |
| | Gulf | 1,826.2 | 334.6 | 31,937.8 | 266.4 | 37.1 | 20.2 | 205.6 | 1,604.4 | 1,955.1 |
| | California | 996.9 | 158.2 | 1,300.3 | 16,258.6 | 3,173.3 | 8,469.2 | 2,015.2 | 104.3 | 448.7 |
| | Pacific Northwest | 39.4 | 0 | 467.0 | 6,188.0 | 1,083.7 | 1,026.1 | 146.0 | 6.4 | 24.9 |
| Noncontiguous | Alaska | 0 | 0 | 0 | 1,569.6 | 1,565.0 | 1,213.9 | 126.2 | 0 | 0 |
| | Hawaii | 59.8 | 0.5 | 140.3 | 3,653.9 | 579.4 | 0 | 1,916.7 | 0 | 28.3 |
| | Puerto Rico | 2,710.4 | 722.3 | 1,148.6 | 368.6 | 0 | 0 | 45.9 | 0 | 0 |
| | Virgin Islands | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

[1]*Less than 100 tons.*
*Source: Maritime Administration.*

**Table IX.30**
**Summary of Domestic Ocean Trade by Region in 1974**
(Thousands of short tons)

| Region | Shipments | Receipts |
|---|---|---|
| Contiguous | | |
| North Atlantic | 53,654.5 | 118,727.7 |
| South Atlantic | 3,041.9 | 21,109.5 |
| Gulf | 96,230.9 | 38,187.4 |
| California | 28,990.8 | 32,924.7 |
| Pacific Northwest | 7,010.6 | 8,981.5 |
| Total Contiguous | 188,928.7 | 219,930.8 |
| Noncontiguous | | |
| Alaska | 10,729.4 | 4,474.7 |
| Hawaii | 4,455.6 | 6,378.9 |
| Puerto Rico | 8,253.4 | 4,995.8 |
| Virgin Islands | 23,413.1 | 0.0 |
| Total noncontiguous | 46,851.5 | 15,849.4 |
| Total Domestic Ocean Trade | 235,780.2 | |
| Total Domestic Ocean Ton-Miles | 322.8 billion | |

*Source: Martime Administration.*

**Table IX.31**
**Projected Domestic Ocean and Miscellaneous Waterways[1] Trade**

| Commodity Group | 1975 | 1980 | 1990 |
|---|---|---|---|
| Fuels and lubricants | 213,967 | 290,245 | 560,607 |
| Durable manufactures | 34,829 | 41,970 | 61,833 |
| Coal | 30,783 | 34,275 | 42,899 |
| Crude oil | 21,214 | 25,848 | 32,841 |
| Mining products | 16,302 | 18,992 | 25,693 |
| Chemicals and allied products | 12,475 | 17,393 | 31,418 |
| Raw and refined sugar | 2,743 | 3,375 | 4,712 |
| Lumber | 2,348 | 2,917 | 4,348 |
| Canned fruits and vegetables | 1,340 | 1,719 | 2,501 |
| Cash grains | 1,297 | 1,447 | 1,864 |
| Primary iron and steel products | 1,279 | 1,462 | 1,872 |
| Agricultural products NEC | 652 | 754 | 981 |
| Nondurable manufactures | 548 | 601 | 710 |
| Fabricated metal products | 503 | 568 | 705 |
| Paper and paper products | 237 | 320 | 552 |
| Grain mill products | 160 | 197 | 286 |
| Nonferrous primary metal products | 160 | 77 | 122 |
| Metal ore | 5 | 8 | 16 |
| Iron ore | 2 | 4 | 10 |
| Total Tons | 340,744 | 442,172 | 773,970 |
| Total Ton-Miles (billions) | 249 | 280 | 351 |

[1]*Includes traffic on Sacramento, Columbia, and Savannah Rivers and the N.Y. State Barge Canal that were not included in the inland waterway projections. Excludes Gulf to Gulf traffic which is included in the inland waterway projections.*

*Source: Maritime Administration,* Domestic Waterborne Shipping Market Analysis.

## Marine Passenger Services

***Marine Passenger Services Today.*** Transportation of passengers in the marine mode is relatively insignificant when compared with air for international travel or with air and automobile/bus for interstate travel.

The waterborne passenger trade has undergone various and dramatic declines in recent years, particularly since the advent of transoceanic jet aircraft service. A notable decline in the number of large passenger vessels (100 gross tons[6] or greater and inspected under chapter I, subchapter H, of Title 46 U.S. Code of Federal Regulations (CFR)) has been accompanied by an increase in small ferry and charter passenger vessels (less than 100 gross tons and inspected under chapter I, subchapter T, of 46 CFR).

Current records indicate that there are 3,833 inspected U.S. vessels engaged in the passenger trade. Of this number, 3,697 are small passenger vessels. While available passenger statistics are not complete, at least 21.4 million persons are carried by these vessels each year.

In addition to these figures, there are an estimated 4,000 vessels that engage in carrying passengers for hire that are not required to be inspected by virtue of their carrying less than seven passengers.

The total number of U.S. vessels engaged in the waterborne passenger trade may exceed 8,000, and the total persons carried is undoubtedly greater than the number stated above.

The construction of bridges, highways, and causeways, each of which has a negative effect on the waterborne passenger-carrying trade, has tended to slow down because of environmental factors. The resultant effect will necessitate the continued use of passenger ferries for ease of movement in metropolitan areas whose proximity to navigable waters will allow utilization of this mode of transportation (e.g., New York City, Seattle, and Galveston).

### Future Marine Passenger Services

The decline in use of large passenger vessels appears to have bottomed out, and tourist cruise ships, mostly foreign flag, are experiencing an increase in total passengers. Large numbers of passengers are transported in small passenger vessels within the inland waterway and Great Lakes systems. While the total number of these passengers has remained fairly

[6]Gross tonnage is the entire internal cubic capacity of a ship—expressed in tons of 100 cubic feet per ton—except for certain spaces such as inner bottom tanks, peak and other tanks for water ballast, open forecastle, bridge and poop, shelter deck spaces, access of hatchway, certain light and air spaces, domes and skylights, wheelhouse, galley, cabins for passengers, etc.

stable, a future increase in total number, compatible with normal population growth, might be expected.

Local and intercity passenger travel by water is expected to increase between 1975 and 1990 while maintaining the same small share of total passenger-miles (0.3 percent). International passenger travel, however, is expected to decline somewhat and to lose most of its share of total international passenger-miles to air (see table IX.32).

**Table IX.32**
**Passenger-Miles by Water**
(Millions)

| Category | 1975 | 1980 | 1990 |
|---|---|---|---|
| Local and Intercity | 4,000 | 4,500 | 6,000 |
| International | 1,884 | 1,835 | 1,550 |
| Total | 5,884 | 6,335 | 7,550 |

## Recreational Boating

***Recreational Boating Today.*** Recreational boating has become an important, rapidly growing industry and activity with an estimated 8.85 million boats in use in 1975 (see table IX.33). The current distribution of each type of boat is not homogeneous.

**Table IX.33**
**Selected Recreational Boat Statistics by Region in 1974**

| Regions | Total Boats All Types | Total Operators | Total Passengers | Boat Hours |
|---|---|---|---|---|
| New England | 1,222,407 | 2,976,551 | 3,508,308 | 186,803,304 |
| Mid-Atlantic | 1,364,575 | 2,692,361 | 3,848,101 | 225,256,557 |
| Gulf Coast | 1,523,664 | 2,369,450 | 4,311,969 | 287,577,859 |
| East Central | 543,161 | 987,187 | 1,613,188 | 87,122,812 |
| Great Lakes | 2,034,456 | 3,889,416 | 5,960,956 | 256,594,165 |
| Mid-West/ Mountains | 684,213 | 1,380,576 | 2,093,691 | 59,593,351 |
| West Coast | 963,867 | 2,074,961 | 3,113,290 | 86,069,613 |
| Total | 8,336,343 | 16,370,502 | 24,449,950 | 1,189,022,661 |

*Source: U.S. Coast Guard.*

Recreational boating is providing commercial waterborne users with increased competition for use of the waterways with the greatest impact at points of congestion such as locks and fleeting areas. Pleasure-boat docking sites also compete with commercial uses of valuable, limited waterfront property. While complete accounting and compilation of statistical data of noncommercial uses of navigation locks have only been begun, table IX.34 shows the heavy recreational use of the waterways during August 1975. This survey clearly indicates that the full cost of building and maintaining the Nation's locks and dams cannot be attributed only to commercial needs.

**Table IX.34**
**Recreational Boat Lockages in August 1975**

| River System | Total Lockage | Total Recreational Lockage | % Recreational | Total Recreational Craft |
|---|---|---|---|---|
| Allegheny | 4,033 | 3,844 | 95 | 5,960 |
| Atlantic Intracoastal WW | 604 | 349 | 58 | 473 |
| Alabama – Coosa | 162 | 93 | 57 | 100 |
| Apalch., Chatt., and Flint | 262 | 136 | 52 | 307 |
| Bayou Teche | 11 | 11 | 100 | 13 |
| Black Warrior and Tombigbee | 796 | 44 | 6 | 92 |
| Cross Fla. Barge Canal | 118 | 115 | 97 | 168 |
| Clinch | 92 | 83 | 90 | 91 |
| Canaveral Harbor | 1,137 | 908 | 80 | 2,093 |
| Cumberland | 857 | 661 | 77 | 933 |
| Dismal Swamp Canal | 295 | 283 | 96 | 388 |
| Freshwater Bayou | 1,845 | 60 | 3 | 782 |
| Green and Barren | 1,101 | 27 | 2 | 40 |
| Gulf Intracoastal WW: Port Allen-Calcasieu | 9,552 | 80 | 1 | 309 |
| Colorado River East-Calo Lieu Bar | 4,659 | 910 | 20 | 6,682 |
| Illinois Waterway | 4,940 | 1,782 | 36 | 5,202 |
| Kanawha | 1,025 | 277 | 27 | 480 |
| Kaskaskia | 280 | 190 | 68 | 238 |
| Mississippi L&D 1-15 | 16,031 | 10,871 | 68 | 25,169 |
| 16-25 | 4,734 | 2,136 | 45 | 3,564 |
| 26 and 27 | 1,395 | 114 | 8 | 293 |
| McClellan-Kerr Ark. River | 3,488 | 2,272 | 65 | 2,704 |
| Monongahela | 5,211 | 1,455 | 28 | 1,742 |
| Ouachita and Black | 152 | 68 | 45 | 110 |
| Old River | 192 | 9 | 5 | 13 |
| Ohio River | 13,230 | 3,196 | 24 | 6,032 |
| Okeechobee WW | 1,758 | 1,572 | 89 | 1,963 |
| Tennessee | 3,112 | 2,129 | 68 | 3,373 |
| Total | 81,072 | 33,675 | 42 | 69,264 |

*Source: U.S. Army Corps of Engineers — Performance Monitoring System.*

The recreational boating fatality rate has declined from 19.0 deaths per 100,000 boats in 1969 to 16.6 deaths per 100,000 boats in 1975 when 1,466 persons were killed in this leisure-time activity. This decline may be largely attributed to the implementation of the Federal Boating Safety Act of 1971 and the resulting growth in Federal and State boating safety programs. As older boats are phased out and new safety and construction standards, established by the Coast Guard, are imposed, the fatality rate is expected to decline further.

Fuel consumption by recreational boats makes an impact on the Nation's overall fuel consumption. During 1975, over 1 billion gallons of gasoline were used by recreational watercraft. Diesel-powered boats constitute less than 1 percent of the total number of boats and their fuel use is relatively insignificant.

***Future Recreational Boating.*** The number of recreational boats is expected to more than double between 1975 and 1990. The number of operators of boats will exceed 32 million, and up to 100 million people may participate in this form of recreation. While the fatality rate is expected to drop, total deaths will increase. Table IX.35 lists some of the significant details of the projections made for future recreational boating activities.

**Table IX.35**
**Recreational Boating Projections**

| Projections | 1975 | 1980 | 1990 |
|---|---|---|---|
| Number of boats (millions) | 8.8 | 11.2 | 18.5 |
| Hours of use per boat per year | 185 | 216 | 225 |
| Fatality rate per 100,000 boats | 16.6 | 13.2 | 12.1 |
| Fatalities | 1,466 | 1,478 | 2,230 |
| Fuel consumption (billions of gallons) | 1.1 | 1.4 | 2.3 |

*Source: U.S. Coast Guard.*

Many recreational boats, particularly outboards and rowboats, can be carried on trailers or on top of cars and recreational vehicles and pose an additional transportation problem. Highway use and congestion will undoubtedly increase and additional boat-launching areas must be made available to the public. Recreational boats will place greater demands on inland waterways and will undoubtedly cause increased congestion at many locks.

## WATERWAY ISSUES AND CONCERNS

### Federal Right-of-Way Investment

***U.S. Army Corps of Engineers.*** The U.S. Army Corps of Engineers Civil Works Program dates from 1824. Harbor and waterway improvements and developments generally fall into the following categories:

- Replacement or nonstructural modifications of outmoded locks to increase capacity;
- Deepening and widening of channels through dredging, river training, low-flow augmentation, and in the case of slack water, raising pool levels;
- Construction of new waterways and extensions of existing routes in order to connect isolated segments of the systems, shorten distances, reduce transportation costs, and penetrate market areas;
- Extension of the navigation season in the northern regions of the network.

Project selection usually begins with the initiation of a request by local governments and citizens. Final selection and priority determination are based on cost-benefit analysis. With the exception of the first category listed above, the Corps must receive specific authorization from the Congress.

The Corps of Engineers has expended approximately $9 billion on navigation between 1824 and the end of fiscal year 1975. New construction has accounted for 63 percent of the expenditures, and operation and maintenance (O&M) for 37 percent. The geographical split of navigation expenditures has been 55.5 percent for inland and intracoastal waterways, 37.1 percent for coastal harbors and channels, and 7.5 percent for Great Lakes harbors and channels. Expenditures for inland and intracoastal waterways construction has formed about 63 percent of all construction, but only 43 percent of O&M.

For the two most recent fiscal years (1974 and 1975) there is a dramatic change in expenditures from the historical pattern (table IX.36). Construction's share dropped to about 50 percent, and was even surpassed by O&M in fiscal year 1975. Inland and intracoastal waterways increased their share to about 64 percent. The inland and intracoastal waterways portion of construction rose to about 83 percent, but its portion of O&M remained steady at about 43 percent.

Table IX.37 shows, in constant 1975 dollars, Corps of Engineers expenditures for navigation since 1959 and the shift in expenditures for construction and operation/maintenance over this period.

Table IX.38 shows the project costs, present status, and estimated completion dates of the three major inland-waterway additions/improvements that will be completed before 1990.

***U.S. Coast Guard.*** The U.S. Coast Guard has been directly involved with marking the waterway right-of-way since 1791 when the first coastal lighthouse built with Federal funds was completed at Portland, Maine. The 48,000 aids to navigation presently being maintained include Loran, buoys, lighthouses, fog signal stations, and radio beacons.

**Table IX.36**
**U.S. Army Corps of Engineers, Civil Works Expenditures in Fiscal Years 1974 and 1975**
(Millions of current dollars)

| | FY-1974 | | | FY-1975 | | |
|---|---|---|---|---|---|---|
| | Total | Construction | Operation and Maintenance | Total | Construction | Operation and Maintenance |
| Inland and Intracoastal Waterways | 393.2 | 256.8 | 136.4 | 418.8 | 282.0 | 136.8 |
| Coastal Harbors and Channels | 180.3 | 46.4 | 133.9 | 192.2 | 48.7 | 143.5 |
| Great Lakes Harbors and Channels | 32.4 | 7.5 | 24.9 | 63.6 | 6.0 | 57.6 |
| Total | 605.9 | 310.7 | 295.2 | 674.6 | 336.7 | 337.9 |

*Source: Construction Operations Division, Directorate of Civil Works, Office of the Chief of Engineers, Department of the Army, Washington, D.C. 1976.*

**Table IX.37**
**U.S. Army Corps of Engineers**
**Navigation Expenditures from 1959-1975**
(Millions of constant 1975 dollars)

| Year | Construction | | Operation & Maintenance | | Total $ |
|---|---|---|---|---|---|
| | $ | % | $ | % | |
| 1959 | 408.0 | 71.0 | 166.7 | 29.0 | 574.7 |
| 1960 | 453.1 | 73.2 | 165.9 | 26.8 | 619.0 |
| 1961 | 462.5 | 71.4 | 185.3 | 28.6 | 647.8 |
| 1962 | 476.5 | 70.6 | 198.5 | 29.4 | 675.0 |
| 1963 | 504.7 | 70.9 | 207.1 | 29.1 | 711.8 |
| 1964 | 469.1 | 68.8 | 212.8 | 31.2 | 681.9 |
| 1965 | 574.3 | 71.9 | 224.5 | 28.1 | 798.9 |
| 1966 | 594.7 | 72.3 | 227.8 | 27.7 | 822.5 |
| 1967 | 544.2 | 71.8 | 213.8 | 28.2 | 758.0 |
| 1968 | 458.0 | 67.2 | 223.6 | 32.8 | 681.6 |
| 1969 | 383.3 | 62.5 | 230.0 | 37.5 | 613.3 |
| 1970 | 326.2 | 55.0 | 266.9 | 45.0 | 593.1 |
| 1971 | 349.5 | 55.7 | 277.9 | 44.3 | 627.4 |
| 1972 | 374.9 | 56.8 | 285.2 | 43.2 | 660.1 |
| 1973 | 308.4 | 50.0 | 308.4 | 50.0 | 616.8 |
| 1974 | 337.9 | 51.3 | 320.7 | 48.7 | 658.6 |
| 1975 | 336.7 | 49.9 | 337.9 | 50.1 | 674.6 |
| Total | 7,362.0 | 64.5 | 4,053.0 | 35.5 | 1,141.4 |

*Source: U.S. Army Corps of Engineers.*

**Table IX.38**
**Planned Expansions to Inland Waterway System Through 1990**

| Project | Project Cost (Millions) | % Complete As of Jan. 1976 | Estimated Completion |
|---|---|---|---|
| Tennessee-Tombigbee Waterway | 1,580.0 | 6 | March 1986 |
| Kaskaskia River Waterway | 131.7 | 76 | March 1980 |
| Smithland Locks and Dam | 238.9 | 57 | June 1979 |
| Total | 1,950.6 | | |

*Source: U.S. Army Corps of Engineers.*

Vessel Traffic Services (VTS) are a recent innovation for traffic management and control in congested or hazardous harbors. Services are now in operation in Puget Sound, San Francisco, and Houston/Galveston. Additional systems are now under construction or planned for completion at Valdez, Alaska, New Orleans, and New York. Other areas being examined and analyzed for potential vessel traffic services are Chesapeake Bay and portions of the Gulf Intracoastal Waterway. Table IX.39 lists the completion year, construction costs, and annual operating costs of the systems that have been authorized or completed.

**Table IX.39**
**U.S. Coast Guard Vessel Traffic Services**

| System | Year Completed | Cost (Millions of 1975$) | Annual Operating Cost |
|---|---|---|---|
| Puget Sound (Seattle) | 1972 | 2.5 | 720,000 |
| San Francisco | 1972 | 7.3 | 704,000 |
| Houston/Galveston | 1975 | 2.8 | 735,000 |
| Valdez, Alaska | 1977 | 7.1 | 1,200,000 |
| New Orleans | 1977 | 3.9 | 1,048,000 |
| New York | 1978 | 7.3 | 1,230,000 |
| **Total** | | **28.9** | **5,607,000** |

Historical data on Coast Guard right-of-way expenditures are not readily available. However, in fiscal year 1974, the Coast Guard spent approximately $112 million (122 millions in constant 1975 dollars) for navigation and recreational boating programs.

## Maritime Safety

The United States commercial maritime industry has an enviable safety record. Table IX.40 highlights some significant statistics for selected years between 1964 and 1975. Vessel casualties include rammings, groundings, collisions, explosions, founderings, and several other categories. Vessel casualty statistics include totals for U.S. vessels worldwide and both U.S. and foreign vessels in United States waters (generally within 3 miles of the coast) and the Great Lakes. Part of the increase in number of casualties between 1964 and 1975 is believed to be the result of improved reporting procedures. The locations of reported casualties is not precise for inland waterways and the coastal area. For the purposes of this table, inland waterways include only those rivers and tributaries on which vessels use the Western Rivers Rules of the Road and exclude, for example, the Gulf Intracoastal Waterway and the Mississippi River south of the Huey P. Long Bridge in New Orleans, both of which are included as part of the inland waterways elsewhere in this chapter. The coastal statistics include these two segments and all accidents occurring in areas where the Inland Rules of the Road apply.

**Table IX.40**
**Commercial Maritime Casualty Statistics**
(By fiscal year)

| Category | 1975 | 1974 | 1969 | 1964 |
|---|---|---|---|---|
| Number of Vessel Casualties | 3,305 | 3,388 | 2,684 | 2,308 |
| Number of Vessels Involved | 5,551 | 5,413 | 4,183 | 3,178 |
| Location of Casualty: Inland Waterways | 557 | 622 | 235 | 195 |
| Great Lakes | 211 | 232 | 183 | 229 |
| Coastal | 1,899 | 1,738 | 1,385 | 1,200 |
| High Seas | 545 | 698 | 680 | 478 |
| Foreign Waters | 93 | 98 | 201 | 206 |
| Vessel Tonnage: Under 300 | 2,788 | 2,765 | 1,763 | 1,281 |
| 300 to 1,000 | 1,055 | 987 | 784 | 490 |
| 1,000 to 10,000 | 993 | 951 | 1,194 | 976 |
| Over 10,000 | 715 | 711 | 442 | 431 |
| Estimated Losses (in $1,000) | | | | |
| Total | 211,430 | 154,649 | 86,462 | 68,355 |
| Vessels | 148,938 | 101,090 | 68,267 | 53,210 |
| Cargo | 21,893 | 12,287 | 10,269 | 12,939 |
| Property | 40,599 | 41,272 | 7,926 | 2,206 |
| Vessels Lost | 325 | 352 | 373 | 380 |
| Deaths/Injuries due to vessel casualties | 190/74 | 199/104 | 217/173 | 191/133 |
| Deaths/Injuries not involving vessel casualties[1] | 190/1,216 | 182/1,265 | 215/2,167 | 182/1,834 |
| Total deaths/injuries | 380/1,290 | 381/1,369 | 432/2,340 | 373/1,968 |

[1]Excludes deaths due to natural causes, homicides, and suicides.
Source: U.S. Coast Guard.

Vessels include all categories of ships and barges, towboats, fishing vessels, passenger and ferry boats, and public vessels but exclude recreational boats. Deaths exclude totals for natural causes, homicides, and suicides. Injury totals are for reported injuries that result in incapacitation in excess of 72 hours.

Of significant interest is the fact that approximately 85 percent of the vessels lost are vessels that are not regulated or inspected by the U.S. Coast Guard (tugs, fishing vessels, small cargo vessels, and other miscellaneous craft).

While projections of fatality rates have not been made, historical data indicate that the number of fatalities in marine transportation has been relatively steady over the past decade and appears to be unrelated to the total tonnage or ton-mileage in this mode.

### Hazardous Material Transportation by Water

The handling, stowage, and movement of hazardous materials in a safe manner afloat and at waterfront facilities is controlled and inspected by the Coast Guard. The Coast Guard is directly involved in all aspects of commercial shipping safety, from plans review to construction, repair, and operation of all U.S. vessels throughout their lifetime. Foreign companies wishing to conduct U.S. trade involving hazardous materials must have their ship's plans approved by the Coast Guard before they can engage in such trade.

The many thousands of hazardous materials that are regulated for the purpose of safe waterborne transportation by the Materials Transportation Bureau and the Coast Guard are classified into one or more of the following categories: explosives, flammable liquids, flammable solids, oxidizing materials, corrosives, compressed gasses, poisons, radioactive materials, or etiologic agents. Transportation of hazardous materials by water has generally proved to be the safest and cheapest means of transport when compared with all modes except pipeline.

Historically, fire was the greatest hazard aboard a vessel, and fire prevention and protection were the main objectives in the safe design of a vessel insofar as cargo hazards were concerned. The tremendous development of modern technology over the past few decades, however, has resulted in many new products presenting hazards other than fire. Many of these products are capable of damaging the environment and property and injuring or killing people far removed from the site of release. New concepts have been and must continue to be developed for such things as cargo compatibility, carcinogenic properties, and spill prevention of hazardous materials and their containment and cleanup. With the increased use of large, specialized vessels, improvements in marine vessel traffic management and control must also continue to be made.

Waterborne transportation of hazardous materials has been steadily increasing as the chemical industry produces new products and adopts new methods of water transportation. The production of organic chemicals, the category that includes many hazardous materials, has grown at an average annual rate of over 10 percent over the past decade. The entire U.S. chemical industry sales are expected to double 1972 sales by 1985 with an annual growth rate of 6.2 percent.

Table IX.41 shows the historical and projected growth of U.S. waterborne commerce of crude petroleum, chemicals, and petroleum and chemical products, the categories that contain almost all hazardous materials.

**Oil and Hazardous Materials Pollution**

The Federal Water Pollution Control Act, as amended by the Water Quality Improvement Act of 1970, gave the Coast Guard responsibility and enforcement authority to protect the marine environment from discharges of oil and other hazardous substances.

Table IX.42 shows the number of reported incidents and volume of oil spilled on U.S. waters as far out as the contiguous zone (12 miles offshore) as well as incidents occurring on the high seas close to U.S. waters. It is important to note that the comparison of 1973 and 1974 data with the number of incidents reported in 1970 through 1972 indicates primarily that the later data are more complete due in large part to more widespread public and industry knowledge of the legal requirement to report discharges of oil. Table IX.43 lists the sources of oil pollution incidents in 1974.

Seventy percent of the volume of spills were a result of hull, tank, pipeline, or pipe system ruptures or leaks, although these causes account for only about 12 percent of the total number of incidents. Eighty-three percent of the volume of spills were caused by single discharges of over 10,000 gallons, although the large spills account for less than 1 percent of the total number of incidents. For example, two incidents in 1974 resulted in the discharge of almost 2.3 million gallons of oil or 13 percent of the total volume spilled.

It can readily be seen that reducing the small number of large spills would have the greatest favorable impact on the marine environment. As new pollution prevention requirements and regulations are imposed, the number and volume of oil pollution incidents should be reduced.

Pollution of the waterways by other hazardous materials, while small in comparison to oil pollution, has been receiving greater attention in the past few years. As these substances and their harmful effects on the marine environment are identified by the Environmental Protection Agency (EPA), new pollution prevention regulations will be promulgated and enforced by the Coast Guard.

**Port Planning and Development**

***Non-Federal Investment.*** Before the 20th century, shore facilities in ports were owned and operated by railroads, terminal companies, and by industries that generated port traffic. The uncoordinated operations of the various facilities and the fierce competition among them created an environment that led to the growth of public port authorities. Today these authorities take a variety of forms and have a variety of jurisdictions including non-port-related activities. Current port facilities include:

- Port Authority facilities leased to carriers on a long-term basis or open for general use;
- Private shipping company facilities primarily for use by the company but also available for use by others;
- Private manufacturing firms' facilities for use by those firms in manufacturing and distributing their products;
- Federal Government terminals including Coast Guard and Navy bases and Corps of Engineers facilities;
- Miscellaneous facilities including recreational boat docks, commercial passenger and ferry terminals, and docking areas for State and local government vessels.

**Table IX.41**
**U.S. Waterborne Commerce of Hazardous Materials**

(Millions of Short Tons)

| | Past | | | | | | Projected | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1972 | | 1973 | | 1974 | | 1975 | | 1980 | | 1990 | |
| | Domestic | Foreign | Domestic | Foreign | Domestic | Foreign | Domestic | Foreign | Domestic | Foreign | Domestic | Foreign |
| Crude petroleum | 103.7 | 143.9 | 90.5 | 197.5 | 83.6 | 216.1 | 88.8 | 229.5 | 106.3 | 178.0 | 112.0 | 347.7 |
| Chemicals and allied products | 45.2 | 23.3 | 44.1 | 25.5 | 46.5 | 25.6 | 48.3 | 27.2 | 63.0 | 79.5 | 93.0 | 156.3 |
| Petroleum and coal products | 322.9 | 110.1 | 330.7 | 139.3 | 323.9 | 112.6 | 344.0 | 119.6 | 401.4 | 129.2 | 507.0 | 251.6 |
| Subtotal | 471.8 | 277.3 | 465.3 | 361.3 | 453.0 | 354.3 | 481.1 | 376.3 | 570.7 | 386.7 | 712.0 | 755.6 |
| Total | 749.1 | | 826.6 | | 807.3 | | 857.4 | | 957.4 | | 1,467.6 | |

*Source: U.S. Coast Guard.*

**Table IX.42**
**Reported Incidents of Oil Pollution**

| Year | Number of Incidents | Volume (gallons) |
|---|---|---|
| 1970 | 3,711 | 15,252,992 |
| 1971 | 8,736 | 8,839,523 |
| 1972 | 9,931 | 18,805,732 |
| 1973 | 13,328 | 24,314,918 |
| 1974 | 13,966 | 16,916,308 |

*Source: U.S. Coast Guard.*

**Table IX.43**
**Sources of Oil Pollution in 1974**

| Source | Number of Incidents | % of Total | Volume in Gallons | % of Total |
|---|---|---|---|---|
| Vessels | 3,726 | 26.7 | 4,286,438 | 25.3 |
| Land Vehicles (including Rail & Highway vehicles) | 373 | 2.7 | 785,548 | 4.6 |
| Nontransportation Related Facilities (including refineries, storage, and production facilities) | 3,644 | 26.1 | 3,468,106 | 20.5 |
| Pipelines | 557 | 4.0 | 6,205,039 | 36.7 |
| Marine Facilities (including fueling and cargo transfer facilities) | 599 | 4.3 | 1,332,342 | 7.9 |
| Land Facilities | 200 | 1.4 | 235,209 | 1.4 |
| Miscellaneous/Unknown | 4,867 | 34.8 | 603,626 | 3.6 |
| Total | 13,966 | 100 | 16,916,308 | 100 |

*Source: U.S. Coast Guard.*

Technological changes have occurred rapidly in the past several decades and have affected all aspects of port operations, planning, and development. Not since the replacement of sails by steam in the 19th century has shipping been subject to such radical change. As the volume of waterborne commerce increased and shipping technology advanced, port communities adjusted, rehabilitated, and developed the necessary supporting terminal facilities to transfer cargo between ship and shore.

Between 1946 and 1972, ports in the United States and Puerto Rico expended more than $3.2 billion for port development, and the port industry is becoming increasingly capital intensive. Table IX.44 shows the regional expenditures for the period 1966–72 as well as the proposed expenditures for the 1973–77 time frame. Of particular significance for the latter period are the Gulf Coast proposed expenditures for liquid- and dry-bulk facilities. Fully 84 percent of these proposed expenditures will be for the two proposed offshore deepwater tanker facilities (SEADOCK and LOOP) that were recently approved by the Secretary of Transportation. Specialized facilities throughout all regions will be mostly intermodal facilities handling containerships and Roll-on Roll-off (Ro-Ro) vessels with barge-on-ship facilities (LASH/SEABEE) accounting for less than 5 percent of the total expenditures.

Port planning and development through 1990 is expected to continue to be handled at the port level, perhaps with more emphasis on regional or commodity load center planning in the years ahead. Greater emphasis on such planning is essential to effective port planning. It is perhaps desirable that a federal decision should be made within the next several years as to whether the Federal Government should be involved in such planning in any way, and if so, to what extent or degree. As shown in the next section of this chapter, Federal decisions often affect the ports but usually as a by-product of some other Federal activity.

Projected domestic and foreign freight movements over the period of 1975 to 1990 may result in substantial capacity problems, both in terms of available carrying capacity and

**Table IX.44**
**U.S. Port Development Expenditures**
(Millions of dollars)

| Region | 1966 to 1972 (actual) | 1973 to 1977 (Proposed) Total | Conventional General Cargo | Specialized General Cargo[1] | Liquid and Dry Bulk Cargo |
|---|---|---|---|---|---|
| North Atlantic | 425.2 | 335.2 | 119.4 | 230.1 | 5.8 |
| South Atlantic | 108.7 | 113.6 | 53.5 | 55.1 | 5.1 |
| Gulf Coast | 181.8 | 594.6 | 52.2 | 45.8 | 496.6 |
| Pacific Coast | 308.7 | 368.0 | 77.5 | 219.1 | 71.4 |
| Alaska, Hawaii and Puerto Rico | 66.3 | 35.7 | 22.3 | 7.6 | 5.7 |
| Great Lakes | 24.9 | 17.3 | 7.4 | 4.1 | 5.8 |
| Total | 1,115.6 | 1,484.5 | 332.3 | 561.8 | 590.4 |

[1]*Container, RO-RO, LASH and SEABEE.*
*Source: U.S. Department of Commerce, Maritime Administration,* North American Port Development Expenditure Survey — 1974.

in terms of transfer facilities. Thus one important issue on the international as well as the domestic front will be the financing and construction of such equipment and facilities in time to be put to appropriate use. Most of the decisions in this area will be made by the private sector and conditioned on international factors including demand, environmental constraints, and the international political and commercial climate. Rather than model this set of factors extensively, it seems appropriate to suggest that particular subsectors of commodity movements and transportation plant and operations will require further scrutiny by both Government and the private sector, to produce timely actions by each as appropriate to meet the needs that will be identified. In general, the private sector needs early indications of long-term Government policy, with respect to energy sources, trade policy, and Government support/regulation, in order to adjust its financial and operating plans to the benefit of all parties.

### Federal Involvement

Within the process of port development, Federal agencies influence a port in at least four basic ways:

- Through allocation of Federal funds for port-related projects;
- Through implementation of existing regulations as they pertain to the siting and operation of terminal facilities and vessel movement;
- Through the formulation of policy that directly or indirectly affects ports;
- Through licensing of deepwater ports.

There is no single Federal agency in charge of formulating the development of a national port policy, thus a myriad of agencies and congressional committees influence port development, and each has the potential to impact significantly port development. These agencies include, but are certainly not limited to:

- Department of Transportation,
- U.S. Coast Guard,
- St. Lawrence Seaway Development Corporation,
- Water Resources Council,
- Council on Environmental Quality,
- Economic Development Administration,
- Department of Defense,
- U.S. Army Corps of Engineers,
- Environmental Protection Agency,
- Department of Commerce,
- Maritime Administration,
- National Oceanic and Atmospheric Administration,
- Office of Coastal Zone Management,
- Federal Maritime Commission,
- Interstate Commerce Commission.

The legislative authorities of some Federal agencies are paradoxical in nature: the Secretary of Defense is responsible for determining the commercial adequacy of a port, while the Secretary of Commerce is responsible for mobilizing ports in wartime; the Secretary of Transportation, through the U.S. Coast Guard's Captains of the Port, is responsible for the safety and security of a port and the movement of vessels in a port area. Fragmentation of power often results in agencies working at cross-purposes to each other.

The Federal Government has consistently supported port development, particularly in the case of public terminals, and has provided various ancillary services to the ports without charge. A key factor in the Federal approach to port development has been to prohibit discrimination among ports either by governmental or private actions. One result of this approach has been that Federal port activities have had little or no apparent effect on the competitive relationship among the ports. Both the port industry and the Federal Government have traditionally supported this situation; however, the increasing policy and economic impacts of Federal activities and regulations could very likely affect port competition in the future. Factors relating to both ecology and technology have further complicated the traditional port development process by requiring new administrative procedures and regulatory actions.

Federal port policy is in an administrative dilemma in that executive agencies can no longer provide services to ports without potentially altering their competitive status. Port development is a component of both national transportation and water resources policy. The underlying problem concerning the Federal role in port planning and development is, quite obviously, the lack of clearly defined national policy for either water resources or water transportation. A unified Government approach to port planning will be necessary, particularly to evaluate the competitive impact on ports as a result of Federal actions. Ports are a vital connection between marine transportation and other modes. Thus the question of port development is one that should be considered within the perspective of the national transportation system as a whole.

Although merchant vessels are the most visible portion of the maritime sector, the operation of commercial vessels is possible only to the extent that they are able to load and discharge their cargoes. Thus port development, including intermodal connections and cargo-handling arrangements, is an important international as well as domestic topic for attention.

Standardization of equipment, rules, and procedures for operating in port areas, as well as the charges levied on vessels and their cargoes, is also a topic of continuing interest and concern to shippers, carriers, and the Government. In addition to our foreign-aid program, sales assisted by the Export-Import Bank can produce both immediate and long-term advantages to the United States and can result in port improvements. To the extent this is an issue, it is primarily in terms of the optimal investments that should be made in U.S. ports and facilities.

Although the Corps of Engineers, the Maritime Administration, and the Department of Transportation are performing port economic analyses, there is at present no formal mechanism to coordinate these studies. No agency is attempting to analyze the economic impact of all Federal actions on the national port structure. A comprehensive national port study could provide this mechanism. Several port aid bills have been introduced in Congress and call for a comprehensive national port study that could fulfill the above objectives if so directed. This legislation, as presently written, would delegate the Secretary of Commerce to conduct a thorough analysis of the Nation's public ports, a study that has never been performed. Effective coordination and cooperation among the Maritime Administration, the Corps of Engineers, and the Department of Transportation must be considered essential in any effort of this magnitude and importance.

## Port and Terminal Capacity

The present Federal approach to port development can be analyzed by considering the results of the process. Inherent in this process is the conflict between national and local interests. Looking at the situation economically from the national viewpoint, if Federal funds contribute to overcapacity, they bring little or no benefit to the Nation as a whole. For example, as long as the building of one more container terminal simply aids the competitive position of a public port authority rather than actually increasing the national flow of cargo or decreasing the overall costs of the national transportation system, the Federal Government would be in the role of subsidizing public utilities to compete with each other. One port might profit by diverting marine traffic from a less modern port.

It is arguable that an overcapacity of container terminals appears to exist in the United States today. Fierce port competition for trade has resulted in container facilities being built but not being used to capacity. Determining terminal capacity is a complex undertaking, and there is not a general consensus about the validity of such determinations as have been made. A study sponsored by the Maritime Administration, *The Impact of Maritime Containerization on the United States Transportation System*, provided a reasonable estimate: 100 percent of a container terminal capacity occurs when each container crane averages 16 hours of work per day, 5 days per week, 50 weeks per year, or 4,000 hours per year. Each container was assumed to make 20 lifts or 10 roundtrips per hour.

This study indicated that the 1975 total container capacity for all trades as a percentage of demand was 250 with a breakdown by regions as follows:

- North Atlantic 240 percent
- South Atlantic 160 percent
- Gulf Coast 90 percent
- Great Lakes 0 percent
- Pacific Coast 570 percent

Although several studies have been made, are presently being conducted, or are planned for the near future, total figures for port, regional, or national capacity are not yet available.

Overcapacity of terminals and facilities does have some advantages. Because of future uncertainties, excess terminal capacity could be helpful in the event of a sudden increase in commerce. The lead time required to build a new facility makes it desirable to have a certain amount of extra capacity. In the event that a major harbor was immobilized by enemy attack or a civil emergency, such as a collision involving vessels carrying toxic or hazardous materials that caused the surrounding area to be temporarily evacuated, terminal overcapacity in other ports would be desirable. Overcapacity would also be useful in the event a labor strike closed down a major port or region.

While there are advantages to overcapacity, there are also definite costs involved. Optimum terminal capacity can be thought of as that capacity that minimizes costs. The most straightforward cost of overcapacity is obviously the amount of funds spent to construct unnecessary facilities. Other costs include the opportunity lost in terms of utilizing the waterfront property because unnecessary duplication of personnel and services means that these resources cannot be better employed elsewhere. Since there are economies of scale in the operation of port facilities, overcapacity results in underutilization and higher unit costs that may be passed on to shippers and ultimately to consumers.

**Waterway-User Charges**

The sensitive issue of waterway-user charges has been debated—without final resolution—for several decades. Positions on this issue vary between two extremes. Opponents of waterway-user charges believe that the use of the waterways should be "forever free" as specified in the Northwest Ordinance of 1787. Proponents of waterway-user charges, on the other hand, believe that the users of the waterways should pay for the Federal expenditures up to and including full recovery of construction, operation, and maintenance costs. The Federal Government gets involved in the decision because user charges would reduce the demand on the general budget and because competing modes, such as railroads, request comparable subsidies.

The relatively low-cost water mode is, quite obviously, vital to the Nation's transportation of liquid and bulk commodities. Water transportation is recognized as being energy efficient; it is also cost-effective on waterway segments that do not require intensive capital investment and maintenance. It is certainly necessary for the Federal Government to continue to maintain and operate water mode facilities and service to realize the Nation's potential growth of waterborne traffic.

Underlying comprehensive transportation policy is the recognition that diversity and intermodal competition are essential to an effective national transportation system. Government policy must move in the direction of increasing equal competitive opportunities among all the transportation modes, promoting competition among modes, enabling each mode to realize its inherent advantages and minimizing the inequitable distortions of Government intervention.

Suggestions for a Federal subsidy policy were spelled out in the Secretary of Transportation's "Statement of National Transportation Policy" on September 17, 1975, and include the following:

- Federal subsidies are necessary in certain instances to serve important national purposes.
- Even when it has been determined that Federal subsidies are really necessary, they should be periodically examined.
- Whenever possible, the costs of Federal support should be recovered by user charges.
- The effect of subsidies on competing modes should be considered, and where there is an adverse effect, the preference should be to reduce or eliminate the subsidy or adjust the user charge so that all users pay their full share.
- There should be a preference for capital rather than operating subsidies; however, care must be taken that capital subsidies do not induce excessive investment.
- Where the political process determines that a subsidy is essential to the national interest because a particular form of transportation serves these interests more effectively than others, the Federal Government should be prepared to take the next step in order to get the full benefit of the subsidy. This involves compatible adjustments in the Federal support of competing modes. The Federal Government should not be inconsistent by continuing to subsidize competing modes, thereby diverting traffic away from the preferred mode and decreasing its chances of economic self-sufficiency.

National waterway policy should be compatible with national transportation policy whenever possible. Waterway carriers do not maintain or pay taxes on the rights-of-way that they use. The national waterway system is under constant improvement by the U.S. Army Corps of Engineers and users of the waterways also benefit from the services of the U.S. Coast Guard.

Within the Department of Transportation, it has become apparent from the increasing criticism of adversely affected carriers that use of the existing public investment criteria for the water mode is inequitable. Either the subsidy to water carriers should be adjusted or the railroads, and perhaps truckers, have a valid argument for a subsidy of similar magnitude. Some common denominator is required against which public investments in alternative modes of transportation can be assessed. Economic efficiency and consideration of equity also lead in the direction of some form of cost sharing. Insofar as it is practicable and adminstratively feasible, the identifiable beneficiaries of federally improved and maintained waterways should bear some share of development and operating costs through a system of user charges.

A number of waterway-user charge studies are being conducted today and, quite obviously, a great deal more needs to be done before this issue is finally resolved. The Department of Transportation's position is that waterway-user charges should be implemented in phases and that sunk costs should not be recovered, However, Administration and Congressional consideration and public debate will be required in the years ahead.

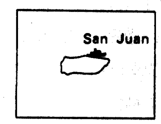
## MARINE TRANSPORTATION SUMMARY

In 1974, 50 ports, each of which handled 10 or more million tons of cargo, accounted for almost 87 percent of the total foreign and domestic waterborne commerce of 1,747 million tons (see fig. IX.10). America's 10 busiest ports handled 789.7 million tons or 45 percent of the total. New York and New Orleans with 195 and 144 million tons, respectively, were the only ports that handled over 100 million tons. These two ports handled almost 20 percent of the total waterborne commerce. There are more than 100 other ports that handled between 1 and 10 million tons of cargo in 1974.

The leading 26 commodities shipped by water accounted for over 86 percent of total waterborne commerce (see table IX.45). The top 10 commodities account for 71 percent of total waterborne commerce.

Estimates of future waterborne commerce were provided by the Maritime Administration, the Army Corps of Engineers, the St. Lawrence Seaway Development Corporation, and the Coast Guard; they are summarized in table IX.46.

Domestic waterborne commerce summaries are shown in table IX.47.




**FOREIGN AND DOMESTIC WATERBORNE COMMERCE**
**(MILLIONS OF SHORT TONS)**

| RANK | PORT | TOTAL TONNAGE | % OF TOTAL WATERBORNE COMMERCE | RANK | PORT | TOTAL TONNAGE | % OF TOTAL WATERBORNE COMMERCE |
|---|---|---|---|---|---|---|---|
| 1 | NEW YORK | 195.1 | 11.17 | 26 | TEXAS CITY | 20.2 | 1.16 |
| 2 | NEW ORLEANS | 144.2 | 8.26 | 27 | NEWPORT NEWS | 17.7 | 1.01 |
| 3 | HOUSTON | 89.1 | 5.10 | 28 | INDIANA HARBOR | 17.2 | [illegible] |
| 4 | PHILADELPHIA | 59.9 | 3.43 | 29 | CONNEAUT HARBOR | [illegible] | [illegible] |
| 5 | BALTIMORE | 59.9 | 3.43 | 30 | LAKE CHARLES | [illegible] | [illegible] |
| 6 | BATON ROUGE | 59.1 | 3.39 | 31 | JACKSONVILLE | [illegible] | [illegible] |
| 7 | NORFOLK | 55.3 | 3.17 | 32 | CALCITE | [illegible] | [illegible] |
| 8 | CHICAGO | 45.9 | 2.63 | 33 | RICHMOND | [illegible] | [illegible] |
| 9 | TAMPA | 40.9 | 2.34 | 34 | SEATTLE | [illegible] | [illegible] |
| 10 | DULUTH-SUPERIOR | 40.3 | 2.30 | 35 | PASCAGOULA | [illegible] | [illegible] |
| 11 | BEAUMONT | 33.5 | 1.92 | 36 | TACONITE HARBOR | [illegible] | [illegible] |
| 12 | MOBILE | 33.1 | [illegible] | 37 | NEW HAVEN | 12.1 | [illegible] |
| 13 | CORPUS CHRISTI | 32.8 | [illegible] | 38 | NEW CASTLE | 12.1 | [illegible] |
| 14 | PAULSBORO | 29.6 | [illegible] | 39 | HUNTINGTON | 12.0 | [illegible] |
| 15 | PORT ARTHUR | 27.8 | [illegible] | 40 | SAN JUAN | [illegible] | [illegible] |
| 16 | PORTLAND-ME | 27.6 | 1.58 | 41 | PORT EVERGLADES | [illegible] | [illegible] |
| 17 | DETROIT | 27.5 | 1.57 | 42 | SILVER BAY | 11.4 | [illegible] |
| 18 | LONG BEACH | 26.9 | 1.54 | 43 | MEMPHIS | 11.1 | [illegible] |
| 19 | LOS ANGELES | 25.9 | 1.48 | 44 | GARY HARBOR | [illegible] | [illegible] |
| 20 | BOSTON | 25.7 | 1.47 | 45 | CAMDEN-GLOUCESTER | [illegible] | [illegible] |
| 21 | MARCUS HOOK & VIC. | 23.4 | 1.34 | 46 | ASHTABULA | [illegible] | [illegible] |
| 22 | CLEVELAND | 21.9 | 1.25 | 47 | BUFFALO | [illegible] | [illegible] |
| 23 | ST. LOUIS | 21.7 | 1.24 | 48 | STONEPORT | [illegible] | [illegible] |
| 24 | TOLEDO | 21.6 | 1.24 | 49 | TWO HARBORS | [illegible] | [illegible] |
| 25 | PORTLAND-OR | 20.8 | 1.19 | 50 | ESCANABA | 10.0 | [illegible] |
| | | | | | TOTAL | [illegible] | [illegible] |

**Figure IX.10. 1974 Ports Handling 10 or More Million Tons.**

While the figures provided by the projections are certainly susceptible to change, several significant facts can be readily observed. Foreign trade will continue to grow at a greater rate than domestic trade. Domestic ocean trade will grow at a greater rate than trade on the Great Lakes or the inland waterways. The lower growth in domestic ton-mileage will be a direct result of greater intraregion traffic, particularly of petroleum products.

The issues discussed in this chapter, as well as those covered in chapter XV on international trade, and other issues not touched on herein, could affect the projections in a substantial manner.

## Table IX.45
## 1974 Total Waterborne Commerce — Commodities in Excess of 10 Million Tons

| Rank Order | Commodity | Tons (Millions) |
|---|---|---|
| 1 | Crude petroleum | 299.7 |
| 2 | Coal and lignite | 208.5 |
| 3 | Residual fuel oil | 193.6 |
| 4 | Iron ore and concentrates | 133.3 |
| 5 | Distillate fuel oil | 95.8 |
| 6 | Gasoline | 95.6 |
| 7 | Sand, gravel,and crushed rock | 81.4 |
| 8 | Corn | 50.2 |
| 9 | Limestone | 46.6 |
| 10 | Wheat | 35.6 |
| 11 | Basic chemicals and products NEC | 33.3 |
| 12 | Soybeans | 25.3 |
| 13 | Phosphate rock | 21.1 |
| 14 | Rafted logs | 19.6 |
| 15 | Aluminum ore and concentrates | 19.5 |
| 16 | Marine shells | 18.1 |
| 17 | Coke, pet. asphalts, solvents | 17.2 |
| 18 | Waste and scrap NEC | 17.1 |
| 19 | Building cement | 14.7 |
| 20 | Iron and steel plates, sheets | 13.2 |
| 21 | Kerosene | 13.0 |
| 22 | Logs | 11.4 |
| 23 | Nonmetallic minerals NEC | 11.4 |
| 24 | Grain products NEC | 10.7 |
| 25 | Jet fuel | 10.3 |
| 26 | Woodchips, staves, moldings | 10.1 |

## Table IX.46
## Summary of Projected Waterborne Commerce from 1975-1990

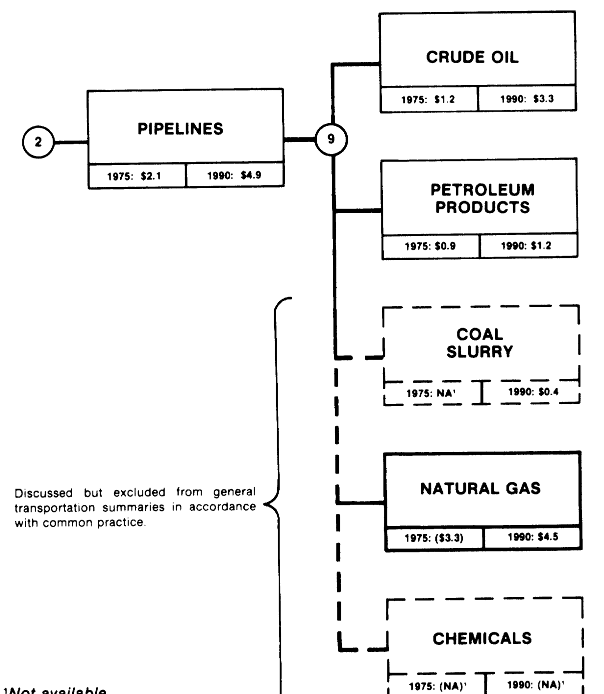
| Year | Domestic | | Foreign | | Total | |
|---|---|---|---|---|---|---|
| | Tons (millions) | Ton-Miles (billions) | Tons (millions) | Ton-Miles (billions) | Tons (millions) | Ton-Miles (billions) |
| 1975 | 1,164.9 | 557.0 | 697.0 | 4,000.0 | 1,861.9 | 4,557.0 |
| 1990 | 1,942.1 | 838.3 | 1,293.0 | 6,500.0 | 3,235.1 | 7,338.3 |
| Growth (Percentage) 1975-1990 | +66.7 | +50.5 | +85.5 | +62.5 | +73.8 | +61.0 |

## Table IX.47
## Summary of Projected Domestic Waterborne Commerce, 1975 and 1990

| | Inland Waterways | | Great Lakes | | Domestic Ocean | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Tons (millions) | Ton-Miles (billions) | Tons (millions) | Ton-Miles (billions) | Tons (millions) | Ton-Miles (billions) | Tons (millions) | Ton-Miles (billions) |
| 1975 | 562.6 | 175.8 | 261.6 | 132.2 | 340.7 | 249.0 | 1,164.9 | 557.0 |
| 1990 | 774.1 | 275.9 | 394.0 | 211.3 | 774.0 | 351.1 | 1,942.1 | 838.3 |
| Growth (Percentage) 1975-1990 | +37.6 | +56.9 | +50.6 | +59.8 | +127.2 | +41.0 | +66.7 | +50.5 |

# CHAPTER X
## Pipelines

Pipelines transport over one-fourth of the total U.S. freight tonnage. In 1975, 440,000 miles of major intercity pipelines carried 1.9 billion tons of cargo. The average distance of the shipments was 428 miles, for a total of 809 billion ton-miles. The value of the cargo shipped was more than $125 billion. The cost of shipping it was $4.8 billion, or about 4 percent of its value. The current and proposed pipeline systems are shown in the Major Pipeline Systems map located in the envelope in the back of the book. A breakdown of the pipeline system is shown in figure X.1.




*Note: The amounts shown are the transportation bills for 1975 and 1990 in billions of dollars.*

**Figure X.1. Transportation Tree.**

The definition or determination of what constitutes transportation and what substitutes for it is not always clear. Pipelines may not always be thought of as transportation. They are unobtrusive; they do not fit the typical image of a vehicle moving between points. In some ways, they have much in common with water pipelines, storm sewers, and power transmission lines, which also do not fit the transportation image. However, pipelines do transport materials in competition with other modes. (Electric power production at the mine and the subsequent transmission of electric power may also substitute for the shipment of fuels.)

Crude oil, petroleum products, coal slurry, and chemical pipelines carry products that may be shipped by rail, ship, or truck. Natural gas is carried only by pipeline. However, if it is converted to cryogenic liquid it may be transported by the vehicular modes. Because they are competitive with the vehicular modes and transport such a large share of the Nation's freight, pipelines are included in this review.

During their 150-year history, U.S. pipelines have been primarily a transporter of energy materials, mainly liquid petroleum and natural gas, but with continuing technical and economic advances, they can also transport liquefied petroleum gases (LPG), liquefied natural gas (LNG), chemicals, anhydrous ammonia and other liquid fertilizers, and even coal or other minerals.

Crude oil and petroleum product pipelines are a regulated industry. Pipelines have developed as part of the oil industry. In the early days, the dominance of the Standard Oil Company over pipelines led to a demand for regulation. The Hepburn Act of 1906 placed pipelines carrying oil and other products, with the exception of water and natural gas, under the jurisdiction of the Interstate Commerce Commission and declared such pipelines to be common carriers. Natural gas pipelines are regulated by the Federal Power Commission.

### PIPELINE SYSTEMS

#### Facilities

Because pipelines are normally buried in the ground, except for an occasional pump or compressor station or terminal, they are invisible. They deliver their products reliably, economically, safely, and with minimum danger of pollution. Recent industry trends have leaned toward the use of large-diameter, high-strength pipe and automated stations with large power units that, in many cases, can operate unattended. Thus, economies of scale should encourage still greater use of pipelines for the future and further reduce unit transportation costs per mile.

Natural gas is gathered from field-production facilities by means of systems that may include field compressor stations, processing facilities, or gas separators and treaters. Gas is usually metered from the gathering facility on delivery to a transmission system where it enters mainline (and generally interstate) transportation for ultimate delivery to a gas distributor's metering point. The transmission system includes mainline pipe, compressor stations, metering stations, pressure regulator facilities, and other related appurtenances. Gas is ordinarily metered and delivered from a transmission line to a gas distributor at the "town border station." Gas distribution facilities include high pressure, intermediate pressure, or low pressure mains, pressure regulation equipment, metering equipment, odorization facilities, control instrumentation, and related maintenance and service equipment. Gas storage facilities may include underground storage wells and injection/withdrawal piping, compressor plants, and LPG or LNG storage and vaporization facilities. Natural gas storage, whether underground or above ground, is generally related to the transportation of the gas.

Crude oil pipelines carry oil from lease tanks, flow lines, and oil-gathering systems through a trunkline system to refineries. Petroleum product pipelines transport products such as gasoline, jet fuel, LPG, and fuel oil from the refineries to bulk terminals and other marketing points—sometimes directly to airport terminals and other major consumers. These pipelines also carry natural gas liquids from gas-processing plants to refineries, chemical plants, or storage and distribution points. A typical petroleum pipeline system includes line pipe, valves, pumping units, station manifolds, tanks, delivery facilities, and control and communications equipment. The principal facilities are the line pipe, pumping stations, and tank farms or terminals.

The transportation of solid materials through pipelines has been receiving increased attention.

Solid materials can also be transported by rail or truck so the effect on competitive modes must be considered. There are two techniques for moving solids through pipelines. One is in the form of slurry, using water or another liquid to carry the commodity through the pipeline. The other, merely a proposal, would use capsules or carrier vehicles moving in a stream of air or liquid.

Engineering techniques have been developed for slurry pipelines to insure trouble-free flows. The slurry consists of crushed solids mixed with water. The particle size and the solids-to-water ratio are designed to produce a fluid that remains homogeneous at the normal operating velocity of about 3 miles per hour. At this velocity, the mixes are neither abrasive nor corrosive. When the pipeline shuts down, solids settle out of the slurry in such a manner as to facilitate restarting, if the grade is not too steep. The energy required to grind the solids, transport the slurry, and retrieve the solids from the water is comparable to that required to transport the same tonnages by other modes. If large-diameter pipe is used, it is often less.

The slurry pipeline system has three major components, each in itself a sophisticated plant facility. Major components are the slurry preparation plant, the transmission pipeline, and the solids-dewatering facility.

Slurry preparation includes crushing the solids to the proper size, mixing them with the proper amount of water, and treating the water to prevent corrosion of the pipeline system and to produce good flow and final separation. The pipeline portion of the system also includes storage tanks and pumps at various points along the line. The dewatering facility includes storage tanks, screens, filters, centrifuges, thermal dryers, and water treatment facilities.

The few thousand miles of chemical pipelines in the United States are used to ship anhydrous (liquid) ammonia, ethylene, and propylene.

### Ownership

Intercity pipelines in the United States are owned and operated by private industry. Some of the major intercity lines, however, were originally constructed by the Government during World War II. In addition to the Big Inch and Little Big Inch lines, the Government has constructed the 154-mile Southwest Emergency Pipeline, the 200-mile Florida Emergency Pipeline, the 179-mile Plantation Extension Pipeline, and the 82-mile Ohio Emergency Pipeline. All these lines are now privately owned.

The total capital investment in intercity pipelines is estimated at $21 billion, as shown in table X.1. At today's prices, this cost would equal about $70 billion.

**Table X.1**
**Estimated Original Investment Cost**
(Billions of dollars)

| Pipeline | Cost |
|---|---|
| Natural Gas | 13.5 |
| Crude Oil and Petroleum Products | 7.0 |
| Other | 0.5 |
| TOTAL | 21.0 |

## Current Status

In 1975, there were about 440,000 miles of intercity pipeline, transporting 1.9 billion tons of products over 809 billion ton-miles at a cost of $4.8 billion. The details of each pipeline system are shown in table X.2.

**Table X.2**
**1975 Status of Intercity Pipeline Transportation Systems**

| Pipeline | Miles | Tons (millions) | Ton-Miles (billions) | Shipping Cost (millions of dollars) |
|---|---|---|---|---|
| Natural Gas | 265,409 | 406 | 326 | 3,286 |
| Crude Oil | 103,127 | 793 | 269 | 654 |
| Petroleum Products | 67,764 | 686 | 211 | 870 |
| Slurry | 273 | 5 | 1 | 8 |
| Chemicals | 4,050 | 14 | 2 | 16 |
| TOTALS | 440,623 | 1,904 | 809 | 4,834 |

The Nation's gas pipeline systems total about 1.4 million miles. In addition to the 265,000 miles of intercity transmission and gathering lines, the network also includes approximately 660,000 miles of distribution mains and 440,000 miles of gas service lines. More than 2,100 operators are involved in the construction, operation, and management of these gas facilities. These gas systems transport about one-third of the Nation's energy supply, serving approximately 44.3 million customers.

In addition to 103,000 miles of intercity petroleum trunklines, several hundred thousand miles of small-diameter pipelines are used to collect crude oil from production fields. The crude oil and petroleum product transmission lines handle approximately one-fourth of the Nation's energy products.

Slurry lines built in the United States include two coal slurry lines and three smaller mineral lines. One of the coal lines—the 108-mile, 10-inch-diameter Ohio line—was built in 1957 and was operated for 6 years at which time the introduction of coal unit trains with lower tariffs made this small diameter line noncompetitive with rail. The 273-mile, 18-inch-diameter Black Mesa, Arizona, line was built in 1970 and is still operating.

Chemical pipelines include an 850-mile anhydrous ammonia line from Texas to Iowa, a 1,100-mile liquid ammonia line from Louisiana to Nebraska, and a 2,100-mile pipeline network that connects a series of ethylene producing and consuming plants along the Gulf Coast from Freeport, Texas, to Plaquemine, Louisiana.

## Energy Used by Pipelines

Both gas and electricity are used to provide power for natural gas transmission lines. Most crude oil and petroleum product lines are powered by electric motors or diesel engines. Table X.3 summarizes energy consumption for each category. Natural gas lines use natural gas as pump-engine fuel.

**Table X.3**
**Utilization of Energy by Pipeline Systems**

| Pipeline System [1] | Btu [2] Per Ton-Mile | Ton-Miles (billions) | Total Btu [1] (trillions) |
|---|---|---|---|
| Natural Gas | 2,150 | 326 | 701 |
| Crude Oil | 300 | 269 | 84 |
| Products | 300 | 211 | 62 |
| Slurry [1] | 750 | 1 | 1 |
| Chemicals | 880 | 2 | 2 |
| Totals | 1,042 | 809 | 850 |

[1]*The pumping for all pipelines decreases in Btu per ton-mile as diameter increases. The only slurry pipeline now operating in the U.S. has a relatively small diameter and hence higher pumping energy requirements.*
[2]*British thermal unit.*

## Environmental Impact

During construction, labor and heavy construction equipment are used intensively in a limited working area. Pipelines are buried for most of their length, however, and the land is usually restored to its original condition and use on completion of the line.

In common with other methods of transportation, pipelines consume energy, principally electricity to drive pumps, although diesel engines and gas turbines are also used. Power station exhaust, associated with the provision of electrical energy, will be concentrated at a few point sources. Therefore, atmospheric contamination from the operation of pipelines is likely to be similar in volume to that from other methods of transportation, but it may be more dispersed than contamination from power station exhaust at fixed locations.

Pipelines are normally buried under cultivated land, and passage through a wooded area can be combined with construction of a firebreak. The only above-ground land the pipeline occupies is at pumping stations and at input and storage terminals. Thus, a pipeline ties up much less land than does a railroad or a highway.

Spillage may result from pipeline damage or failure. The volume that can escape is controlled by valves. Actual losses per ton-mile handled have been less for pipelines than for road, rail, and water shipments, and the risk of concentrated local damage is no greater with a pipeline than with other modes. Any spillage into water is, of course, damaging to wildlife and sometimes to property.

Coal slurry pipelines are unique in using water as the fluid transportation medium—about 737 acre-feet for every 1 million tons of coal moved. Underground sources supply this water in arid western areas, which could lead to serious environmental consequences if a drop in the water table level were to result. Water sources for coal slurry pipelines must, therefore, be carefully evaluated.

Except at the terminals and pumping stations, which are at fixed locations, pipelines operate silently. Pipeline routes are inspected regularly by aircraft to detect signs of incipient damage, but flights are relatively infrequent and made only in daylight hours. Thus a pipeline is substantially less of a nuisance than are other modes.

### Safety

All pipeline systems are regulated with regard to safety. The Natural Gas Pipeline Safety Act of 1968, the Transportation of Explosives Act, the Hazardous Materials Act, and various provisions of numerous other Acts are intended to prescribe and enforce safety standards for the design, construction, operation, and maintenance of pipelines. Nevertheless, pipeline systems are subject to accidents and failures that result in injuries and deaths. In 1975, 14 deaths were reported as a result of accidents at natural gas line sites, and 7 were reported involving liquid pipeline systems.

### Eminent Domain

Most natural gas, crude oil, and petroleum product pipelines have rights of eminent domain under either Federal or State laws. Once construction has been approved by the relevant government agencies, property owners cannot refuse rights-of-way to the pipeline. Proposed Federal legislation to give coal slurry pipelines the right of eminent domain is now being opposed by railroad interests. A proposed pipeline from Wyoming to Arkansas must cross railroad property at 51 points along its route, and cannot be constructed without either rights of eminent domain or railroad cooperation.

## PIPELINE PLANS

### Supply and Demand Forecasts

Forecasts of future changes in U.S. pipeline systems are based on various scenarios of energy supply and consumption, and are described in figure X.1 and table X.4. These forecasts are based largely on an analysis by the Pace Company of Houston, Texas. Despite expected shortages, which should result in higher prices, demand for energy is expected to grow. This will result in an increase in pipeline

**Table X.4**
**Pipelines — 1975 Estimates and 1990 Forecasts**
(in dollars)

| Category | 1975 | 1990 |
|---|---|---|
| Crude Oil Trunkline | $ 654 million<br>793 million tons<br>269 billion ton-miles | $3,351 million<br>1,007 million tons<br>552 billion ton-miles |
| Petroleum Products Trunkline | $ 870 million<br>686 million tons<br>211 billion ton-miles | $1,188 million<br>856 million tons<br>261 billion ton-miles |
| Other Crude Oil and Petroleum Products Pipelines | $ 624 million | |
| TOTAL | $2,148 million<br>1,479 million tons<br>480 billion ton-miles | |
| Gas Trunklines | $3,286 million<br>406 million tons<br>326 billion ton-miles | $4,509 million<br>404 million tons<br>333 billion ton-miles |
| Coal Slurry | $ 7.6 million<br>4.8 million tons<br>1.3 billion ton-miles | $ 477 million<br>80 million tons<br>72 billion ton-miles |
| Chemicals | N.A.[1]<br>15 million tons<br>2.38 billion ton-miles | N.A.[1]<br>26 million tons<br>4.77 billion ton-miles |

[1]*Not available.*

shipments, as shown in table X.4. Additional pipeline requirements will also be generated by shifts in the location of sources and, to a lesser extent, in the location of demand. These forecasts may also be affected by competition between pipelines and unit trains designed to carry pipeline products. The unit trains may be found to be the lower cost mode in those special circumstances when the demand for the product builds up too slowly to warrant an immediate use of pipeline or the duration of the flow is over a period of years that are too few to warrant the high capital cost of a pipeline.

Two assumptions used in developing this forecast have far-reaching implications for future pipeline growth. First, it was assumed that all crude oil and natural gas liquids from the Alaskan North Slope would move by sea from Valdez to the U.S. West Coast following trans-Alaska pipeline shipment. Second, it was assumed that all natural gas from the Alaskan North Slope would make this journey as LNG. After regasification, the natural gas would be fed into existing gas pipelines for West Coast use. Gas normally moving into California would be consumed elsewhere.

The assumptions regarding transportation of Alaskan North Slope natural gas were supported by the following reasons:

- The all-U.S. line can be put into operation sooner because it does not require Canadian approval, and it can be constructed faster because it parallels the trans-Alaska oil pipeline and is smaller in diameter than the Alaskan-Canadian gas pipeline.
- The delivered price of the gas by LNG tanker shipment would be comparable to the pipeline price, considering likely Canadian national and provincial taxes and the cost of moving the natural gas from the U.S. border to consuming areas.
- The United States would collect more money in taxes and would not be affected adversely in its balance of payments by using the all-U.S. system.
- The trans-Alaska line would bring gas to Fairbanks and industry to Alaska.

Both Alaskan gas delivery systems appear technically and economically viable. The trans-Alaska gasline and LNG tanker system is believed to be more viable in view of the earlier prospective operation and better project definition. Because the all-pipeline project would require regulatory approval of two sovereign governments and negotiation of the equity share of each company, delays might be substantially longer than for the all-U.S. system. Use of the trans-Alaska oil pipeline right-of-way also should simplify approvals and permit earlier solutions to engineering and environmental problems. Either system may find it difficult to meet the 1981 timetable projected earlier. Consideration was not given to alternative proposals for building gas and crude oil pipelines through Canada to the Northern United States because various factors might delay them beyond 1990.

Should the Alaskan-Canadian gas pipeline be constructed, the various movements of natural gas within the United States and resulting pipeline projects would need to be changed accordingly. Basically, this would involve movement of natural gas from North Central U.S. points of entry to consumers in other parts of the Country. It would also change the pattern of natural gas movements from the West Coast to inland U.S. markets.

Production of petroleum and natural gas within the 48 mainland States is expected to decline from the 1975 level, and there will be an increase in "imports" from the Alaskan North Slope and from foreign sources. Therefore, there will be a decline in transfers from the oil and gas resource areas on the Gulf Coast to consumers in other parts of the Country and a tendency to deliver foreign energy directly to the point of consumption. To analyze this effect, it is necessary to divide the 48 contiguous States into several areas. U.S. Bureau of Mines statistics show energy consumption in and transfers between five Petroleum Administration for Defense Districts (PADD's), and these were the areas chosen for analysis. The States included in each PADD are shown in figure X.2. For convenience in this report, these five Districts are named the East, South, Central, Mountain, and West regions.

The changes in natural and synthetic gas flows between PADD's are shown in table X.5 and figure X.2. These changes are caused more by changes in source than in demand. Reduced production resulting from depletion in the South will reduce flows from that area to all other districts. The East is expected to com-

## Pipeline Transfers of Natural and Synthetic Gas

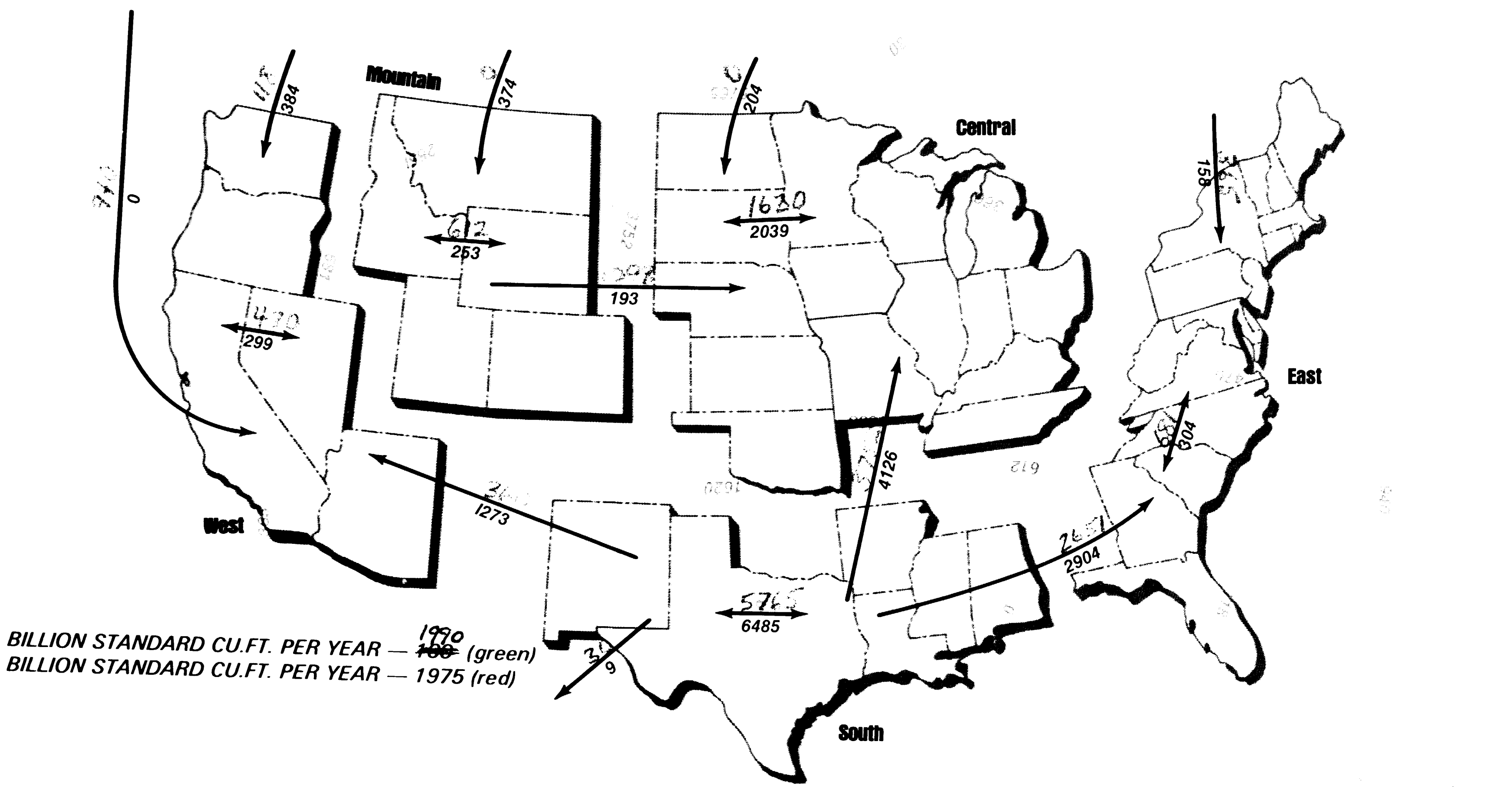



FIGURE X.2. PIPELINE TRANSFERS OF NATURAL AND SYNTHETIC GAS.

# ERRATA for PB 282 230

## National Transportation Trends and Choices

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| | | |
|---|---|---|
| East | - | numbers should read<br>365 green, 158 red<br>681 green, 304 red<br>2651 green, 2904 red |
| South | - | numbers should read<br>5765 green, 6485 red<br>3752 green, 4126 red<br>30 green, 9 red<br>360 green, 1273 red |
| West | - | numbers should read<br>470 green, 299 red<br>940 green, 0 red<br>118 green, 384 red |
| Mountain | - | numbers should read<br>0 green, 374 red<br>612 green, 253 red<br>1098 green, 193 red |
| Central | - | numbers should read<br>0 green, 204 red<br>1620 green, 2039 red |

Legend should read
Billion Standard Cu. Ft. per year - 1990 (green)
Billion Standard Cu. Ft. per year - 1975 (red)

pensate for these losses by increasing its own production of petroleum synthetic gas and later adding to its supply from new offshore sources. The Central region will lose imports from Kansas, Oklahoma, and Canada; however, it will receive substitute flows from the synthetic gas production originating at the Mountain region coal fields.

Imports from Alaska to the Western States will cause a major reduction in gas flow from the South to the West. This decrease will release pipeline capacity that may be used for the reverse flow of crude oil, as shown in figure X.2.

Table X.6 and figure X.3 describe the expected changes in pipeline flows of crude oil between regions. The Central region may experience an increase in demand that will generate increased pipeline movements of crude oil into that area. Crude oil flows from the South to the Central region are expected to rise despite the depletion of the South's oil fields. The shortfall will be alleviated by crude oil inputs at Gulf State ports and crude oil flows from Alaska to the West and then to the South.

The petroleum industry believes that commercial petroleum deposits may exist in three areas on the Atlantic Outer Continental Shelf. From North to South, these are the Georges Bank area, the Baltimore Canyon area, and the Blake Plateau area. Exploration in these areas is expected to begin in the next 1 to 5 years. If this is successful, development is expected to begin immediately thereafter. If significant quantities of petroleum are discovered in these areas, pipelines to shore should be built by 1985. These pipelines would run west from each of these areas to the coast, and onshore pipelines would distribute the crude oil from landing points to existing refineries in the Delaware Bay area and in northern New Jersey, and possibly to new refineries in the coastal plains of the Middle and South Atlantic States.

One or more deepwater ports will be built in the Gulf of Mexico off Louisiana or Texas in the relatively near future. These ports will be connected to the new Texoma and Seaway pipelines, which connect the Gulf to Oklahoma, and to Capline and other pipelines moving crude oil north to Chicago refineries.

The completion of the trans-Alaska pipeline in 1977 will satisfy most West Coast refinery requirements by sea, and will leave some oil for transportation to other crude-short areas. Three possible routes, not mutually exclusive, have been suggested to move this crude eastward. One would originate at Kitimat, British Columbia, and connect to the Interprovincial-Lakehead system at Edmonton, Alberta. A second would originate at Port Angeles, Washington, and terminate in Minnesota. The third would move oil from Long Beach to west Texas for further movement to the midcontinent and Midwest refining areas. The southernmost pipeline would be based on the reversal of an existing gas transmission line.

Petroleum development in Alaska will continue. Large amounts of petroleum may become available in Alaskan areas outside the Prudhoe Bay and Cook Inlet fields, which are currently being exploited. There is every reason to believe that there are large quantities of

**Table X.5**
**Pipeline Transfers of Natural and Synthetic Gas**
(Billion standard cubic feet per year)

| From \ To | East (PADD 1)[1] | | Central (PADD 2) | | South (PADD 3) | | Mountain (PADD 4) | | West (PADD 5) | | Totals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 |
| East (PADD 1) | 304 | 681 | | | | | | | | | 304 | 681 |
| Central (PADD 2) | | | 2,039 | 1,620 | | | | | | | 2,039 | 1,620 |
| South (PADD 3) | 2,904 | 2,651 | 4,126 | 3,752 | 6,485 | 5,765 | | | 1,273 | 360 | 14,788 | 12,528 |
| Mountain (PADD 4) | | | 193 | 1,098 | | | 253 | 612 | | | 446 | 1,710 |
| West (PADD 5) | | | | | | | | | 299 | 470 | 299 | 470 |
| Alaska | | | | | | | | | 0 | 940 | 0 | 940 |
| Foreign | 158 | 365 | 204 | 0 | (9) | (30) | 304 | 0 | 384 | 118 | 1,111 | 453 |
| Totals | 3,366 | 3,697 | 6,562 | 6,470 | 6,476 | 5,735 | 627 | 612 | 1,956 | 1,888 | 18,987 | 18,402 |

[1] *Petroleum Administration for Defense Districts*

**Pipeline Transfers of Crude Oil**

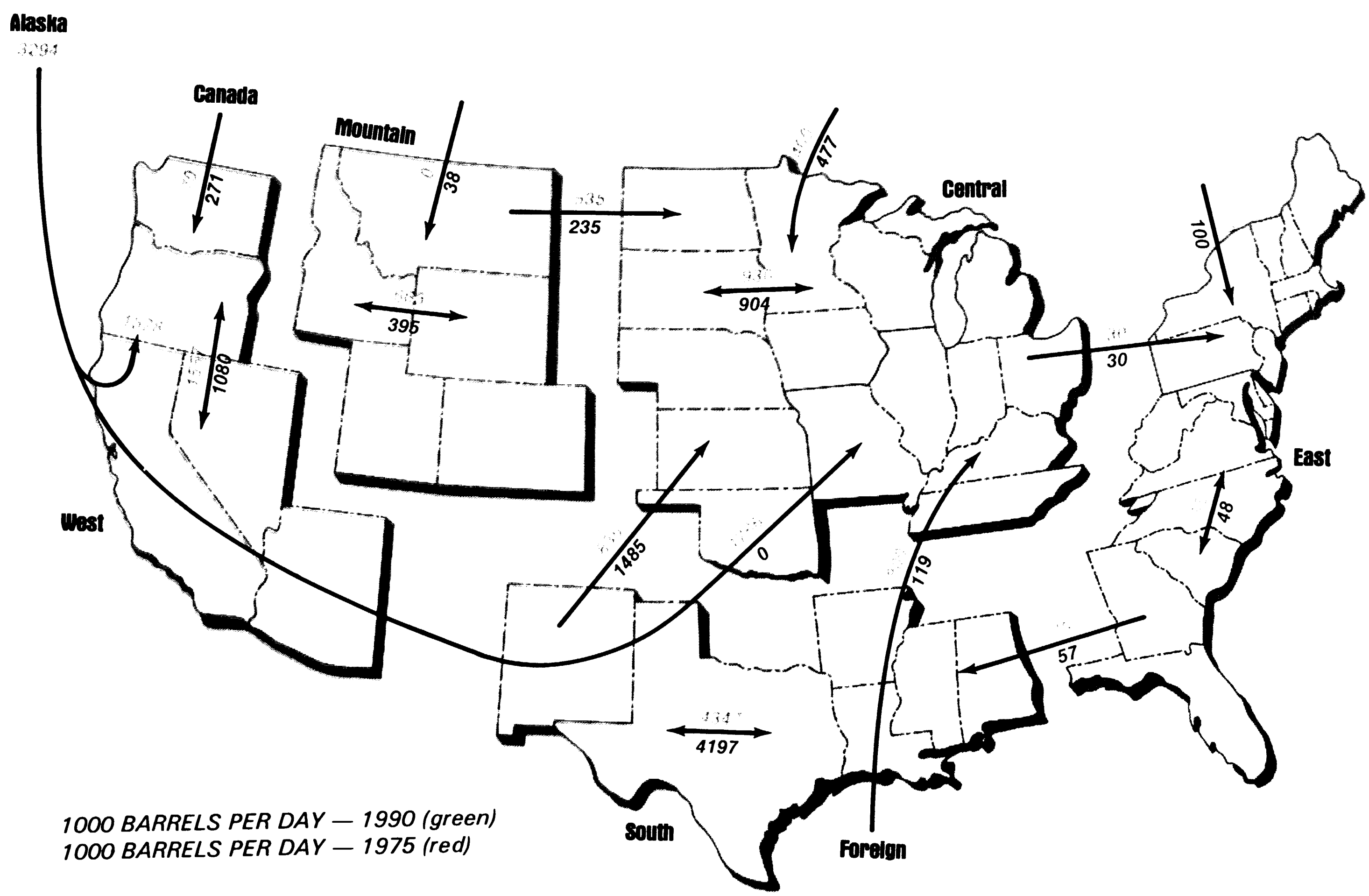


**FIGURE X.3. PIPELINE TRANSFERS OF CRUDE OIL.**

petroleum available west of the Prudhoe Bay area in Navy Petroleum Reserve 4. Industry is hopeful that petroleum can be discovered in other areas of Alaska, particularly in east central and west central Alaska and offshore in the Arctic Ocean, the Bering Sea, and the Gulf of Alaska. Exploration in the latter two areas is expected to begin in the near future. Still other promising petroleum regions exist on the North Slope. The demand for petroleum by 1990 and the depletion of existing domestic sources will probably require that such fields be produced at some time during the next 15 years. Petroleum produced in these areas would be pipelined to the nearest warm-water port for shipment to the lower 48 by tankship. The disposition there would be the same as for petroleum from the trans-Alaska pipeline.

Further offshore production can be expected off the California coast and the Gulf of Mexico seaward of existing production. Any petroleum developed in these areas would be pipelined to connect with existing offshore and onshore pipelines.

Petroleum product pipeline flows are described in table X.7 and figure X.4. The only important change between 1975 and 1990 will be an increase in the magnitude of flows from the South to the Central region and Eastern States. For many years the Gulf Coast, Midcontinent, and Mountain regions produced more crude oil and natural gas liquids than they needed. The surplus has been transferred to the East region, the Central region, and the West region as crude oil and as petroleum products. Refineries generally are located optimally with regard to these traditional flows. Ordinarily, it is less expensive to move petroleum products to consumers from existing refineries than to build new refineries at the optimum location. It is expected that the existing refineries in the Central region will process crude oil inputs from Alaska, and that the additional need for petroleum products will be met by pipeline transfers of petroleum products from refineries in the South. By 1990, additional pipeline capacity is expected from the South to the Central region. Construction of a product pipeline from Houston-Baton Rouge to south-central Florida will be needed to supply the eastern Gulf Coast area and Florida with petroleum products. One such project has been announced; it would involve the conversion of one loop of an existing gas transmission line to product service. All other improvements in the petroleum products pipeline systems are designed either to increase capacities or to reduce costs by increasing pipeline size or pumping pressures.

Coal movements between various U.S. regions are indicated in table X.8 and figure X.5. As the table shows, a significant growth in coal demand is expected.

Potential coal slurry pipeline routes are shown on the map in the pocket at the end of this document. Generally they are in locations requiring long-distance movements where adequate rail capacity is not currently available. For the most part, this condition is more likely to be found in the West than in the East, and will most

**Table X.6**
**Pipeline Transfers of Crude Oil**
(1,000 Barrels/day)

| From \ To | East (PADD 1)[1] | | Central (PADD 2) | | South (PADD 3 | | Mountain (PADD 4) | | West (PADD 5) | | Totals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1975 | 1990 | 1975 | 1990 | 1075 | 1990 | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 |
| East (PADD 1) | 48 | 65 | | | 57 | 35 | | | | | 105 | 100 |
| Central (PADD 2) | 30 | 30 | 904 | 930 | | | | | | | 934 | 960 |
| South (PADD 3) | | | 1,485 | 836 | 4,197 | 4,347 | | | | | 5,682 | 5,183 |
| Mountain (PADD 4) | | | 235 | 535 | | | 395 | 665 | | | 630 | 1,200 |
| West (PADD 5) | | | | | | | | | 1,080 | 1,567 | 1,080 | 1,557 |
| Alaska | | | 0 | 1,766 | | | | | | | 0 | 1,776 |
| Through Foreign | | | 119 | 800 | | | | | | | 119 | 800 |
| Through Canada | 100 | 0 | 477 | 400 | | | 38 | 0 | 271 | 70 | 886 | 470 |
| Totals | 178 | 95 | 3,220 | 5,267 | 4,254 | 4,382 | 433 | 665 | 1,351 | 1,627 | 9,436 | 12,036 |

[1]*Petroleum Administration for Defense Districts*

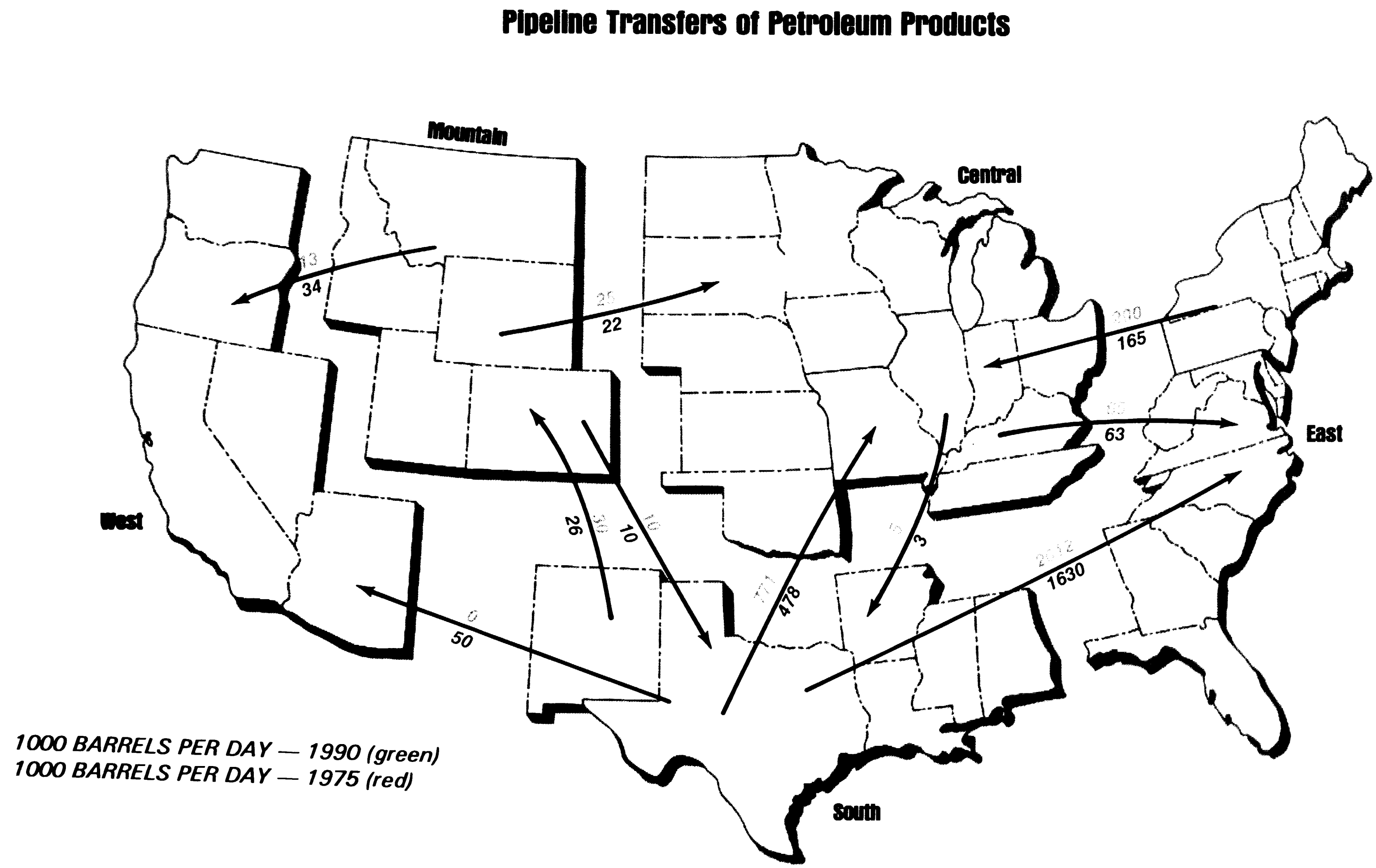


FIGURE X.4. PIPELINE TRANSFERS OF PETROLEUM PRODUCTS.

likely affect the western coal fields in the Mountain States. As discussed earlier, pipelines transporting large volumes of coal over long distances may be able to compete with railroads if new trains or new tracks are required. A public policy decision should be made, however, as to whether the future costs to society are less if the movement is by rail or by coal slurry pipelines.

Increases in the use of pipelines for transporting chemicals will depend on the growth in demand for anhydrous ammonia, ethylene, and propylene and whether competing modes can do the job as efficiently. Forecasts indicate a 5-percent annual growth in liquid ammonia moved from the Gulf Coast. Tons moved per year are expected to increase from 2 million in 1975 to 3.8 million in 1990. Ethylene production is expected to grow from 17.2 billion pounds in 1975 to 33 billion pounds in 1990. Similarly, propylene production will grow from 8 billion to 18 billion pounds per year during that period.

### Pipeline Investment Projections

Pipeline investment projections are consistent with the forecasts of changes in supply and demand for the various pipeline products and the various proposals of facilities required to respond to these changes. Projections have been developed for all systems, with due consideration of the role that can be played by competitive modes. Unless converted to a cryogenic liquid, natural gas can be transported only by pipeline. Other energy products, however, may also be transported by rail, ship, or motor carrier.

A new natural gas pipeline will be needed to move natural gas from the Alaska North Slope to Valdez, at which point the gas will be liquefied and shipped to the West Coast by tanker. Another pipeline will be needed to move synthetic natural gas from plants in the Mountain region to the Central region. Accordingly, natural gas pipeline construction is forecast in accordance with table X.9.

The crude oil pipelines investment estimates for 1975–90 are reported in table X.10. Specifically, the estimate assumes that:

- By 1977 — A line is to be completed to increase flows from the South to the Central region by 726,000 barrels per day.
- By 1980 — Shipment of 500,000 barrels per day will be initiated from the West to the Central region via the South.
- By 1990 — New capacity will be installed adequate to move 1.2 million barrels a day between the West and the Central region.
- By 1990 — New capacity will be installed to move 260,000 barrels a day of synthetic crude oil from Mountain region coal fields to the Central region.
- By 1990 — Capacity additions to the Alaska pipeline will be completed.

The pipeline investment requirements for petroleum products are largely related to improving the efficiency of the existing system. In addition to lowering costs of transportation generally, the improvements will permit flows to increase by 382,000 barrels per day between the South and the East regions by 1977, by 293,000 barrels per day from the South to the Central region by 1977, and by an additional 229,000 barrels per day between the South and the Central regions by 1990. Capital expenditures are described in table X.11.

A number of proposals and plans have

**Table X.7**
**Pipeline Transfers of Petroleum Products**
(1,000 Barrels/day)

| From \ To | East (PADD 1)[1] | | Central (PADD 2) | | South (PADD 3) | | Mountain (PADD 4) | | West (PADD 5) | | Totals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 |
| East (PADD 1) | | | 165 | 200 | | | | | | | 165 | 200 |
| Central (PADD 2) | 63 | 65 | | | 73 | 75 | | | | | 136 | 140 |
| South (PADD 3) | 1,630 | 2,012 | 478 | 771 | | | 26 | 30 | 50 | 0 | 2,184 | 2,813 |
| Mountain (PADD 4) | | | 22 | 25 | 10 | 10 | | | 34 | 13 | 66 | 48 |
| West (PADD 5) | | | | | | | | | | | | |
| Totals | 1,693 | 2,077 | 665 | 996 | 83 | 85 | 26 | 30 | 84 | 13 | 2,551 | 3,201 |

[1]*Petroleum Administration for Defense Districts*

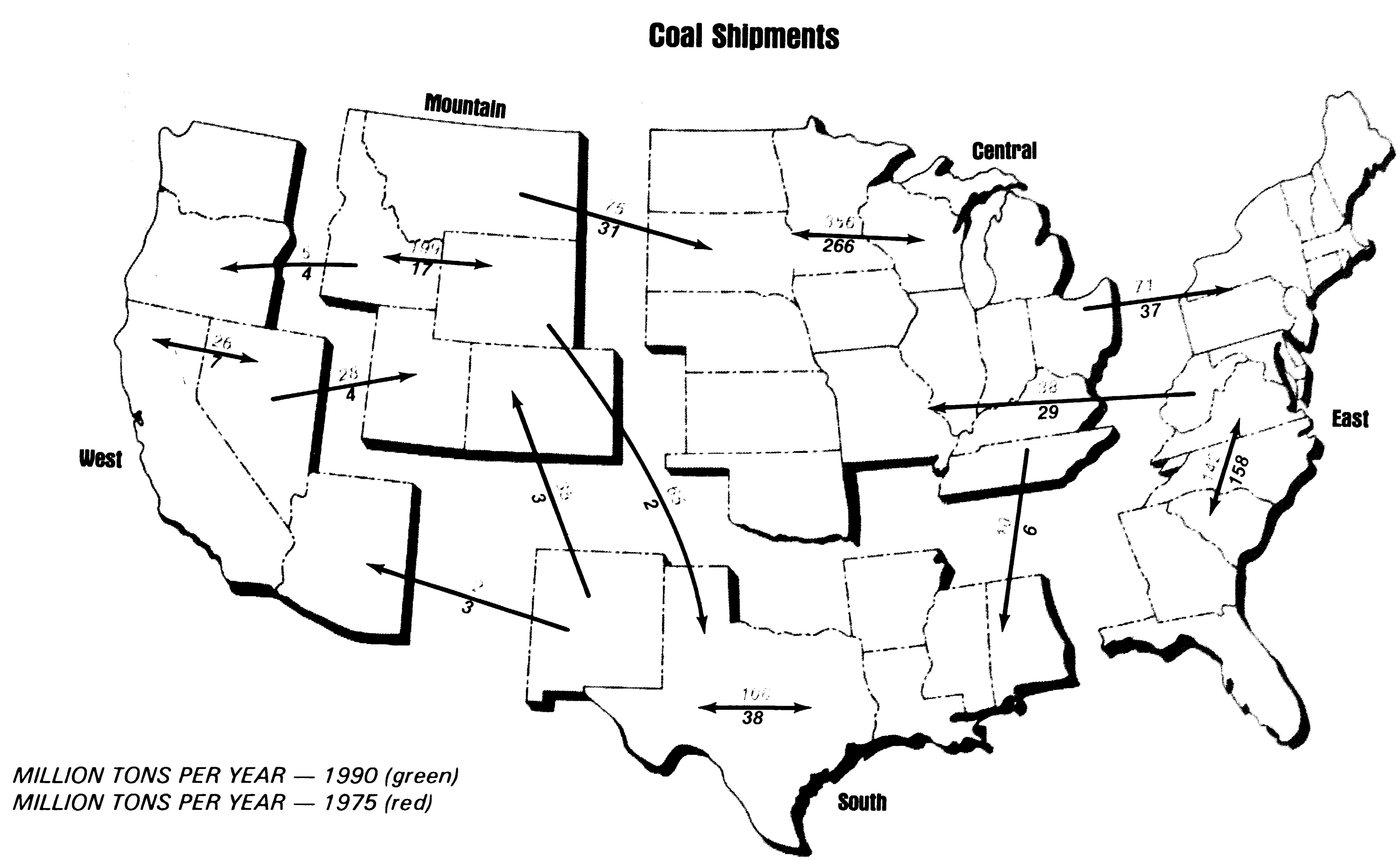


FIGURE X.5 COAL SHIPMENTS.

been prepared by private industry for the transportation of coal slurry by pipeline. The investments for each of these proposals are described in table X.12, and their location is shown on the map in the pocket at the end of this document.

No industry proposal has been made for the Montana-Great Lakes line, but it is included because it seems probable that a pipeline will be proposed. No estimate has been included for the proposed Edmonton-Great Lakes line.

Additional pipelines will be required for ammonia, ethylene, and propylene movements. Current proposals are described in table X.13. All proposals are for work to be completed by 1990.

Total pipeline mileage is expected to remain the same through 1990. Nevertheless, over 73,000 miles of new pipelines will be required. About 74,000 miles of older lines will be retired. Capacities will be increased considerably as old, smaller diameter, less efficient lines are retired and new, larger diameter, high-strength pipe and more efficient pumping compressor stations are installed. Table X.14 describes the additions and deletions by system.

Generally, deletions and additions tend to balance out, both across time and across modes.

**Table X.8**
**Coal Shipments**
(Million tons per year)

| From \ To | East (PADD 1)[1] | | Central (PADD 2) | | South (PADD 3) | | Mountain (PADD 4) | | West (PADD 5) | | Totals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 | 1975 | 1990 |
| East (PADD 1) | 158 | 142 | 29 | 38 | | | | | | | 187 | 180 |
| Central (PADD 2) | 37 | 71 | 266 | 356 | 6 | 10 | | | | | 309 | 437 |
| South (PADD 3) | | | | | 38 | 106 | 3 | 35 | 1 | 3 | 43 | 144 |
| Mountain (PADD 4) | | | 31 | 75 | 2 | 65 | 17 | 199 | 3 | 5 | 54 | 344 |
| West (PADD 5) | | | | | | | 4 | 28 | 7 | 26 | 11 | 54 |
| Totals | 195 | 213 | 326 | 469 | 46 | 181 | 24 | 262 | 13 | 34 | 604 | 1,159 |

[1] *Petroleum Administration for Defense Districts*

**Table X.9**
**Estimated Investments in Gas Pipelines**
(1975-1990)

| Period | Total Mileage Added | Average Mileage Per Year | Millions of 1975 Dollars Invested | Average Spending Million Dollars Per Year |
|---|---|---|---|---|
| 1975 to 1977 | 4,500 | 1,500 | 3,150 | 1,050 |
| 1978 to 1980 | 4,500 | 1,500 | 3,150 | 1,050 |
| 1981 to 1985 | 10,777 | 2,155 | 8,765 | 1,753 |
| 1986 to 1990 | 8,500 | 1,700 | 6,400 | 1,280 |
| TOTAL | 28,277 | 1,767 | 21,465 | 1,280 |

**Table X.10**
**Estimated Investments in Crude Oil Pipelines**
(1975-1990)

| Period | Total Mileage Added | | Average Mileage Per Year | | Average Millions of Dollars Per Year | | Average Millions of Dollars Per Year | |
|---|---|---|---|---|---|---|---|---|
| | North Slope | Total | North Slope | Total | North Slope | Total | North Slope | Total |
| 1975 to 1977 | 798 | 3,891 | 266 | 1,297 | 7,000 | 7,540 | 2,333 | 2,513 |
| 1978 to 1980 | – | 2,500 | - | 833 | 200 | 1,000 | 67 | 333 |
| 1981 to 1985 | 798 | 4,098 | 266 | 820 | 2,000 | 2,950 | 400 | 590 |
| 1986 to 1990 | – | 3,500 | - | 700 | – | 1,000 | – | 200 |
| TOTAL 1975 to 1990 | 1,596 | 13,989 | 100 | 874 | 9,200 | 12,490 | 575 | 781 |

## Table X.11
## Estimated Investments in Petroleum Products Pipelines
(1975-1990)

| Period | Total Mileage Added | Average Miles Per Year | Millions of 1975 Dollars Invested | Average Million Dollars Per Year |
|---|---|---|---|---|
| 1975 to 1977 | 4,003 | 1,334 | 852 | 284 |
| 1978 to 1980 | 3,600 | 1,200 | 720 | 240 |
| 1981 to 1985 | 6,500 | 1,300 | 1,300 | 260 |
| 1986 to 1990 | 8,300 | 1,660 | 1,820 | 364 |
| Total 1975 to 1990 | 22,403 | 1,400 | 4,692 | 293 |

## Table X.12
## 1975-1990 Coal Slurry Pipeline Proposals

| Category | Origin: Utah | Origin: Wyoming | Origin: Colorado | Origin: Wyoming | Origin: Montana/Wyoming | Total All Schemes |
|---|---|---|---|---|---|---|
| | Destination: Nevada | Destination: Arkansas | Destination: Texas | Destination: Oregon | Destination: Great Lakes | |
| Total Movement (Million Tons/Year) | 10.0 | 44 | 20 | 20 | 59 | 157.8 |
| Coal Slurry (Million Tons/Year) | 10 | 25 | 10 | 10 | 20 | 79.8 |
| Pipeline Length (Miles) | 180 | 1,036 | 750 | 1,100 | 1,200 | 4,266 |
| Pipeline Traffic (Billion Ton Miles/Year) | 1.8 | 25.9 | 7.5 | 11.0 | 24.0 | 71.5 |
| Pipeline Diameter (Inches) | 22 | 38 | 22 | 22 | 36 | |
| Investment 1975 dollars per inch mile | 20,000 | 19,000 | 20,000 | 20,000 | 19,000 | |
| (Billion Dollars) | 0.08 | 0.75 | 0.33 | 0.48 | 0.82 | 2.46 |

## Table X.13
## 1975-1990 Chemical Pipeline Additions

| Chemical | Pipeline Miles | Million Tons Per Year | Cost (Million $) |
|---|---|---|---|
| Ammonia | 1,100 | 1.1 | 340 |
| Ethylene and poly-propylene | 1,900 | 0.39 | 380 |

## Table X.14
## Forecast of Pipeline Miles
(1,000 Miles)

| | 1975 | 1975 Additions | To 1980 Deletions | 1980 | 1980 Additions | To 1990 Deletions | 1990 |
|---|---|---|---|---|---|---|---|
| Natural Gas | 265.2 | 10.5 | 11.5 | 264.2 | 19.3 | 16.5 | 267.0 |
| Crude Oil | 56.9 | 6.9 | 9.3 | 54.5 | 7.6 | 13.2 | 48.9 |
| Petroleum Products | 64.9 | 10.4 | 9.8 | 65.5 | 14.8 | 14.2 | 66.1 |
| Coal | 0.273 | 0.180 | 0 | 0.453 | 3.336 | | 3.789 |
| Chemicals | 4.6 | 1.0 | - | 5.6 | 3.0 | | 7.6 |
| TOTAL | 391.9 | 29.0 | 30.6 | 390.3 | 47.7 | 43.9 | 394.1 |