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Cargo Logistics Airlift Systems Study (CLASS)

Volume 1. Analysis of Current Air Cargo System

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Langley Research Center
Hampton, Virginia 23665

CARGO/LOGISTICS AIRLIFT SYSTEMS STUDY (CLASS)

VOLUME I – ANALYSIS OF CURRENT AIR CARGO SYSTEM

JUNE 1978

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for

Langley Research Center
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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PREFACE

In June 1977, the Douglas Aircraft Company (DAC)was awarded Contract No. NAS1-14948 for the Advanced System Division (ASD) of NASA/Langley Research Center, Langley Field, Virginia, to perform a Cargo/Logistics Airlift System Study (CLASS). The scope of this study as defined by the NASA Work Statement was as follows:

- Characterize current air cargo operations
- Survey shippers to determine nature of demand
- Develop commodity characteristics leading to high elegibility for air transport
- Determine sensitivity of demand to improved efficiency
- Identify research and technology requirements

To comply with the scope of the study, the effort was segregated into five discrete tasks.

Task 1 was the analysis of the current air cargo system with the objective of clearly understanding what the air cargo operation is today and how prevailing conditions might impact on the 1990 time period. It can be noted here that during the preparation of the Task 1 report deregulation of the air cargo industry was signed into law. The affects of this legislation are not reported and the discussion is maintained as originally written prior to the legislation. This approach was taken in consideration for the short term during which any observation would be presumptuous.

Task 2 was to perform case studies with the objective of determing current distribution characteristics, total distribution cost concepts and their application, and the factors the consignor or consignee considered in their transport mode selection. Concurrent with the case studies was the development of a 1990 scenario designed to provide a framework for the total future environment, within which a 1990 market forecast and the 1990 system characteristics are postulated.

The findings of Tasks 1 and 2 provided the basic information necessary to accomplish Task 3, which was to define the characteristics and require-

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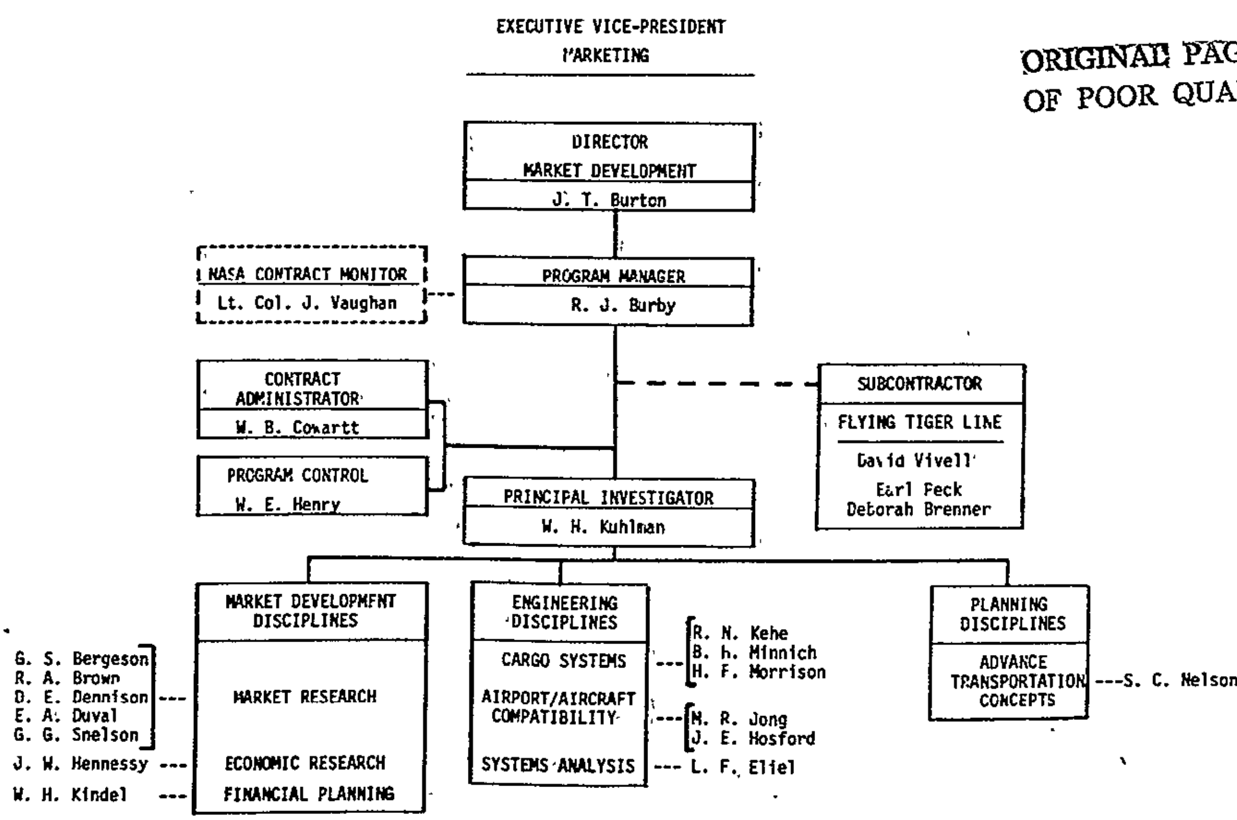
ments for the 1990 system. In this task, the market and system growth factors were identified followed by a domestic and international forecast of the 1990 freight market.

The objective of Task 4 was to explain the cross impacts that exist between the air cargo market, technology development and implementation, and the operation of the air physical distribution system. Emphasis was placed upon identifying the factors which had to be considered to measure the possibility of achieving the NASA-defined goals of a 30-percent reduction in aircraft direct operation costs, a 40-percent reduction in indirect operating costs, and a 45-percent reduction in total operating costs. Task 5 identified future system and technology studies and was conducted as an integral effort within all tasks.



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The Douglas CLASS study organization is shown above. Douglas is pleased

to acknowledge the excellent contribution made to the project by personnel of the Flying Tiger Line and, in particular, David Vivell, Director of Marketing Research; Earl Peck, Senior Economic Analyst; and Deborah Brenner, Director Advertising. It should be noted that the Flying Tiger team had prime responsibility for Sections 2, 4 and 5 of Volume I; Case Study Approach and Results, Volume II; and Section 6 of Volume III. In addition, they contributed to Section 5 and assisted in the analysis encompassed by Section 2 of Volume I. Douglas appreciates the keen interest and support provided by the NASA contract monitor Lt. Col. John Vaughan.

The study results comprise five volumes:

- Volume I - Analysis of Current Air Cargo Systems, NASA CR158912
- Volume II - Case Study Approach and Results, NASA CR158913
- Volume III - Cross Impact Between the 1990 Market and the Air Physical Distribution Systems, NASA CR158914
- Volume IV - Future Requirements of Dedicated Freighter Aircraft to Year 2008, NASA CR158950
- Volume V - Summary, NASA CR158951

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ABBREVIATIONS

AADA	Airport and Airway Development Act
ATA	Air Transport Association
ATC	Air Transport Corporation
AWB	Airway Bill (airbill)
CAB	Civil Aviation Board
CAN	Committee on Aircraft Noise
CFR	Code of Federal Regulations
CLC	Consignor-Loaded Container
COFC	Container on Flatcar
COMAT	Airline Company Materials
CRAF	Civil Reserve Air Fleet
DAFRI	Domestic Air Freight Rate Investigation
DOC	Direct Operating Costs
DOD	Department of Defense
DOT	Department of Transportation
DWT	Dead Weight Tons
ETV	Elevating Transfer Vehicles
FAA	Federal Aeronautics Act
FAR	Federal Aeronautics Regulations
FMC	Federal Maritime Commission
GNP	Gross National Product
GRP	Gross Regional Product
HBR	High By-pass Ratio
IATA	International Air Transport Association
ICAO	International Civil Air Organization
ICC	Interstate Commerce Commission
IOC	Indirect Operating Costs
LASH	Lighter Aboard Ship
LCL	Less Than Carload (rail)
LD	Less Developed
LDC	Lower Deck Container Series
LTL	Less Than Truckload
MAC	Mean Aerodynamic Chord
MTOGW	Maximum Takeoff Gross Weight

OAG	Official Airline Guide
O-D	Origin-Destination
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of Petroleum Export Countries
PU&D	Pickup and Delivery
ROA	Return on Assets
ROI	Return on Investment
RRRR(4R)	Railroad Revitalization and Regulatory Reform Act
RTKM	Revenue Tonne-Kilometers
SAF	Society of American Florists
SFAR	Special Federal Aeronautics Regulations
SITC	Standard Industrial Transportation Code
TAA	Transportation Association of America
TDC	Total Distribution Concept
TEU	Twenty-foot-Equivalent Unit
TOC	Total Operating Costs
TOFC	Trailer on Flatcar
TOGW	Takeoff Gross Weight
UD	Underdeveloped
ULD	Unit Load Device
UPS	United Parcel Service
WPL	Weight of Payload

2.4 x 2.4 x 6 meter- metric definition of current 8 x 8 x 20 foot container

SUMMARY

The material presented in this volume of the CLASS final report summarizes highlights of the analysis of the current air cargo system. It should be remembered that any conclusions drawn from the material should apply to current air cargo system characteristics and not to what direction the air cargo system seems to be moving. Douglas and Flying Tiger Lines have made every effort to keep the observations and findings relating to the current systems as objective as possible in order not to bias the analysis of future air cargo operations reported in Volume 3 of the CLASS final report.

Domestic Airfreight

- Analysis of the transportation of major commodities by the three modes (air, truck, rail) indicates that major city-pair commodity movement is primarily intraregional rather than interregional. The term and region designates a limited area that can comprise one state or a limited number of adjacent states.
- The average lengths of haul in kilometers as defined by the Transportation Association of America for the period of 1970 to 1975 are: truck-466, rail-832, and, air-1659.
- Although the air mode has shown significant annual percentage gains, the amount of commodities transported by air is a small percentage of the toatl for three competitive modes. From 1970-1975, air-transported commodities averaged 4.9 billion tonne-kilometers compared to 752.0 billion tonne-kilometers for truck and 1,168.0 billion tonne-kilometers for rail.
- The total domestic airfreight market in 1976 was 4.2 billion tonne-kilometers. Ten city-pairs accounted for 20 percent or 843 million tonne-kilometers of this total.
- During a 9-year period, three city pairs (origin-destination) LAX-NYC, SFO-NYC, NYC-LAX have consistently remained in first, second, or third rank out of the top 10.
- LAX-CHI has been the fastest growing city-pair, increasing from eighth rank in 1968 to fourth in 1972 and maintaining that rank through 1976.

- A seasonal pattern exists in airfreight transportation with the greatest decrease taking place between the fourth and first annual quarters.
- Quantity of airfreight carried on the total top 10 city-pairs has either declined or held constant for the years 1973 - 1976. Of the individual top city-pairs, none shows a continual pattern of growth or decline for the period 1973 - 1976.
- Analysis of capacity offered and quantity carried for the 5-year period, 1972-1976, fails to indicate either a constant positive or negative correlation or a lead-lag relationship for the top 10 city-pairs. From these data, we can surmise that short-range trend lines are not a major factor in allocation of capacity to routes - assuming that excess capacity is available.
- Major commodity classification transported by air remain relatively constant over the years. For example, wearing apparel has held first through fifth rank out of 10 for a 20-year period.
- Small shipments have long been considered a characteristic of commodities shipped by air. In fact, 75 percent of the total air shipments weigh less than 90 kilograms.
- Twenty four-digit SIC commodity classifications accounted for 85 percent of all commodities transported by air in 1972.
- Airfreight is used for 7 percent of the total value of printed products. Motor carrier has an 83 percent share and the remaining 10 percent is by rail.
- Seven produce commodities account for 89 percent of all air-shipped produce originating in California, which is the origin of 45 percent of total produce transported intercity.
- In 1969, approximately 30 percent of the 139 million kilograms of cut flowers transported domestically were moved by air. Available information indicates that the current share for the air mode has decreased considerably, although this commodity remains in the top ten commodities transported by air.
- An important step in determining cost causative factors in airfreight shipment was the data generated by the Domestic Air Freight Rate Investigation. This investigation provided tools for the analysis

of cost distribution in terminal operations. It concluded that terminal costs are sensitive to type of commodity shipped, its weight and the number of pieces in the shipment.

- Since terminal costs are fixed, regardless of the distance flown, they represent a likely area within which to achieve reduction in total operating costs for short haul operations.
- A cost causative rate structure was developed in the DAFRI proceedings (multielement rate structure). This formula is currently used to calculate maximum rates allowable for various types of shipments. The multielement rate structure includes a factor which is designed to allow the carriers a 12-percent return on investment.
- The airfreight industry (as well as air transportation industry) is capital intensive and, as a consequence, is sensitive to equipment price fluctuations and cost of capital. Airfreight costs are even more sensitive to cost increases in fuel, flight crew, and traffic servicing.
- Recent developments in wide-bodied aircraft are able to minimize the sharp rise in operating costs by greater marginal increases in capacity (cost/ton-mile).
- Despite the reductions in operating costs/ton-mile the airfreight carriers have experienced difficulty in realizing a fair return on investment. A logical approach to the future would be to first take advantage of these potential cost reductions by increasing profits and realizing a fair return on investment and then attempt to capture new markets by discounting.

<u>U.S. International and Foreign Airfreight</u>

- Commodity flow statistics for U.S. export/import trade are provided in several format printouts by commodity description, weight in kilos, dollar value, and dollar value per kilo by sea and by air.
- United Nations statistics are between country pairs and illustrate total trade in terms of commodity description, weight in kilos, dollar value, and dollar value per kilo.
- Six U.S. gateways generate more than 80 percent of U.S. 1976 export/import traffic.

- Forty percent of U.S. dollar exports are to the Western Bloc of European countries; over 30 percent moves to Asia.
- Asian countries comprise over 40 percent of U.S. imports and the European Bloc accounts for less than 25 percent of U.S. imports.
- Each market appears to have its own, unique seasonality characteristic.
- In the trade between the U.S. and selected countries, high-value air-potential commodities moving by sea have been identified.
- All-freighter aircraft service between the U.S. and selected countries has deteriorated (1972-1976) with the exception of service in the Pacific and South America. This same observation is true for the foreign markets analyzed with the exception of London-Frankfurt.

Air Eligibility Criteria

- Freight is categorized as being emergency, perishable, or divertible. Each category has been analyzed in terms of mode choice decision process, decision process inputs, market, and other considerations.
- Limited use of total distribution cost concepts and incorrect computation of inventory carrying costs are seen to inhibit airfreight growth.
- Six market types were identified that are compatible with an expanding volume of air-eligible freight: new (or test) markets, markets with demand variability, customer service sensitive markets, geographically dispersed markets, immature markets, and markets in developing countries.

Current Direct Support Infrastructure

- Airports selected for study were Los Angeles International Airport (LAX), J.F. Kennedy International Airport (JFK), Atlanta William Hartsfield International Airport (ATL), Chicago O'Hare International Airport (ORD) and Detroit Metropolitan Wayne County Airport (DTW).
- All five survey airports are encountering ground access problems. The airports have recognized this problem and are providing additional facilities or redesigning existing facilities.

- Because of environmental issues, new construction programs have encountered varying degrees of delay
  - Sepulveda tunnel strengthening at LAX delayed 8 years.
  - Runway length increase programs have ceased at JFK.
  - Opposition to most airport improvement programs is viewed by airport authorities as becoming increasingly stronger in the years to come.
- JFK, ORD, and ATL are experiencing heavy runway delays.
- One of the major constraints to obtaining more efficient facilities is the limited availability of money.
- Four terminals were surveyed at LAX and DTW, five at JFK and ORD, and one in ATL. In addition, a visit was paid to Federal Express in Memphis to observe small-piece handling.
- A considerable number of terminals surveyed had design baselines that bore no resemblence to actual operating conditions.
- Few terminals have been designed with adequate floor area for staging outbound bulk cargo.
- Nearly all current terminals surveyed are at maximum physical size and cannot expand at present sites.
- As flow levels increase, most terminals surveyed will have to expand their cargo processing areas, either horizontally or vertically.
- Personnel costs represents the largest single element of terminal operating costs at approximately 60 to 80 percent for a conventional cargo terminal.
- In order to minimize costs and relieve congestion it may be necessary to employ joint operations at terminals or to provide off-airport processing sites.
- Some airlines favor contoured pallets while others prefer containers. This acts as a deterrent against standardization which is desirable because of economic forces and interline facilitation.

Comparative Mode Analysis

- Air, motor carrier, railroad, and ocean freight transportation modes were compared using these characteristics: amount shipped, modal choice selection criteria, current tariff structures, transit times, and service factors.
- Air comprised only 0.2 percent of the total domestic transport tonne-kilometers.
- For domestic U.S. shipments, truck is least costly means of small shipment transport (146 of the 150 cases considered) and also in 39 of 60 cases for large shipments of over 980 kilometers. Rail was the least costly for the remaining 21.
- For small shipments, 45 kilograms, there are many instances, origin-destinations and commodities, where air tariffs are less than sea tariffs. However, within the 500 cases investigated it was found that air tariffs on clothing between Rio de Janiero and New York varied between 21 to 44 percent of sea tariffs over the full range of weight breaks.
- Airfreight line haul transit times for domestic routes are 1/2 to 1/5 of the motor carrier transit times and 1/3 to 1/6 of the rail transit times. For international routes the airfreight transit times are approximately 1/11 to 1/27 of the ocean freight transit times.
- International transit times are penalized by custom delays that range from hours to days depending upon the gateway and transport mode.

Political and Economic Factors

- The effect of economic and political factors has been analyzed in terms of international agreements, noneconomic regulations, economic regulations, economic variables, competitive modes, and the civil reserve air fleet (CRAF). A matrix has been prepared which summarizes the degree of effect of these factors on a set of current and future airfreight system components.
- Internationally, the Bermuda II agreement is among the most influential of recent actions. This agreement is viewed as a model for future bilateral and multilateral international agreements.

- Domestically, the current considerations of deregulation or modification of current air cargo regulations will, if realized, have reaching consequences that will impact not only the air cargo and aircraft industries but all industry that relates to the air mode of transportation.
- Operating restrictions instigated by noise and pollution control are having far-reaching impacts on air cargo operations which prefer utilization of night-time hours to achieve the desired door-to-door, overnight delivery schedule.
- Landing fees are rapidly becoming a serious expense item for both domestic and international operations.
- Noneconomic regulations are being enacted at ever-increasing rates and results in regulatory expectations that are unfavorable to rapid decisions regarding equipment acquisition.

Future Potential Market Areas

- Growth in the future air cargo market will be realized through expansion of the overall freight movement due to growing trade, the diversion from surface to air or through the creation of new markets. The rationales leading to the identification of future potential market areas are categorized under World Freight Movement, Emerging Markets, and Airfreight penetration.
- It is postulated that the southern portion of the U.S. and countries in South America, West Central Africa, Mid-East and the Far East regions are prospective high-growth markets for airfreight.
- A key to achieving high growth in these emerging markets may be through the application of total distribution cost concepts backed up by an aggressive educational/sales effort.

Section 1

ANALYZE CURRENT ROUTES

Over the past years, there has been a steady growth in the airfreight market and the supporting airfreight system. Prior to an analysis of the future operations, it is necessary to establish a documented overview of conditions as they exist today. This section provides this overview in terms of primary domestic, U.S. international, and foreign routes. Data are presented that define the level of services provided, volumes transported, and commodities shipped as affected through seasonal patterns and changes in the total environment. Included is a detailed analysis of airfreight costing characteristics, considering line haul and terminal costs, and the associated domestic rate fare structure.

Major Domestic Freight Markets

This section of the Cargo/Logistics Airlift Systems Study (CLASS) provides a comprehensive description of the domestic airfreight market in the United States. The two primary concerns, sources of data and airfreight networks, are represented as follows:

- Sources of data were located and analyzed in depth to determine the level and quality of detailed statistics available.
- Introductory statements to the airfreight networks describe the analytical procedure to determine domestic commodity networks for the three modes (air, truck, rail) for selected Standard Industrial Classification Code (SIC) four-digit commodity classifications and the results. These results lead to the analysis of airfreight networks comprised of the 10 major matching city-pairs. The city-pairs are analyzed from the standpoint of their relationship to total domestic airfreight and to total airfreight as reported in Douglas Domestic Shared Statistics. In addition, this section includes a study of the annual shifts in rank of the top 10 city-pairs, an investigation of the seasonality factor, and in-depth

comparison of freight carried, capacity offered, and frequencies per week for each of the 10 city-pairs.

Three of the major air-transported commodities, printed matter, fresh fruits and vegetables, and cut flowers, are nonmanufactured items and, therefore, were not included in the 1972 Census of Transportation. For this reason, other sources of data were acquired and have been used to provide an analysis of these commodities.

Sources of U.S. domestic data and description of computer models. - Prior to award of the CLASS contract to MDC, a file of pertinent information was established at the Market Information Center (MIC) at MDC. This file currently contains 160 documents, economic and technical, relating to domestic and international cargo. This information was obtained by personal visits to appropriate government agencies, associations, airlines, and surface carriers and by telephone and written communication.

This special data collection supplements the extensive and diversified air cargo studies which MDC has conducted for two decades in the interest of MDC airline and all-freighter customers and for advance planning of aircraft design for the future.

A list of the data sources and data that were evaluated and/or used includes libraries as shown below; numerous U.S. international and private departments, agencies, and associations; and the documents listed or referenced in text.

LIBRARIES:

Transportation Association of America
Bureau of Railway Economic Library
Federal Aviation Agency Library
DOT - TSC Technical Information Center
Transportation Center Library - Northwestern University
National Academy of Sciences - Maritime Research Information Service - Highway Research Information Service
American Trucking Association, Inc. - General Library
Transportation Institute - Library

U.S. Civil Aeronautic Board - Library
Marketing Information Center, McDonnell Douglas Corporation

The Competition Summary computer Program is a computer program that uses the Official Airlines Guide (OAG) as input data. Output reports can be provided for any selected airline showing all origin-destinations for all services offered, including all-cargo services. The cargo version of this program displays capacity available at each origin city in the passenger lower holds or in freighter aircraft. The model is used to determine cargo capacity offered over major air transportation routes.

The domestic shared statistics model shows on-line city-pair freight traffic in pounds for each quarter since 1967. The information is provided to MDC by American Airlines, United Airlines, TWA, Flying Tigers, Airlift International, Continental Airlines, and Western Airlines. These carriers are furnished a quarterly report and an annual summary which provides industry traffic flow (both front haul and back haul) for every market reported, each carrier's market share, the top 1000 markets ranked by tons and ton-miles, and the top 100 terminals ranked by tons originated. This program is used to identify major airfreight markets in the U.S. and to characterize these markets by showing historical quarterly growth and decline plus seasonality.

Numerous marketing research and economic approaches were experimented with to achieve the objective of presenting the most accurate and complete presentation of the current domestic freight market. One of the major efforts was to produce a comparison of freight movement by city-pair, commodity, and mode that would offset the well-documented deficiencies of the 1972 Census of Transportation. The primary problem encountered in this effort was the lack of comparable origin-destination data since much of the data are presented in terms of shipment areas or regions. However, this research was fruitful in that certain of the findings are applicable to other tasks.

Major air markets were selected by use of the MDC-generated Domestic Shared Statistics Program. In addition, the historical trend of total airfreight from 1960 to 1976 has been provided. Also included are comparisons of freight carried, capacity offered, and frequencies. The comparative charts in this section are based on MDC Domestic Shared Statistics and the OAG Competitive Analysis.

Discussion of major commodities transported by air required the use of numerous sources including special computer runs from the Census of Transportation and data from the Air Transport Association. Data sources for non-manufactured commodities, specifically, fresh fruits and vegetables, printed matter, and cut flowers, were difficult to locate. However, these data were essential as these three commodities are in the list of nine major commodities transported by air.

Charts and tables concerning fresh fruits and vegetables were prepared from statistical data provided by the United States Department of Agriculture. Specifically, these are "Fresh Fruit and Vegetable Unloads," 1972-1976, FVUS-2 and "Air Shipments of Fresh Fruits and Vegetables," 1972-1976. Information on this subject was also obtained from several airline studies.

Information concerning the transportation of printed matter was obtained from the Printing and Publishing Industries Division of the Bureau of Domestic Commerce. These data were collected in a separate survey made in conjunction with the Census of Transportation.

Data concerning transportation of cut flowers were prepared from information provided by the Society of American Florists.

Airfreight networks. - The original organization of this portion of the study included a section on commodity networks in which the three major modes (air, truck, and rail), were combined. Transportation of the 50 major four-digit SIC commodities by three leading city-pairs was to be considered. Basic data source for this analysis was the 1972 Census of Transportation (Reference 1-1).

Examination of the composite printout revealed that when three modes (air, truck, rail) are considered for the top 50 four-digit commodities and the three top ranking city-pairs, the result does not provide national network of prime commodity flows. For nearly all of the 50 commodities, the three top ranking city-pairs are located in the same region. For example, the commodity SIC 3714 "Motor Vehicle Parts and Accessories" has these major networks:

Origin	Destination	Percent of Total SIC
Detroit	E. North Central	8.77
Cleveland	Detroit	3.96
Indianapolis	Detroit	2.64

All of these origins and destinations are in the east north-central region. There is a plausible explanation for the result. Growth of supporting industries probably has in nearly every instance occurred within close geographical proximity of major industrial centers as transportation costs are a major factor in the decision to establish a business.

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It can be assumed that the percentage of the commodity which was air transported was destined for regions other than the producing region. Since the preceding data show that the majority of movement is intraregional, it is understandable that the portion of manufactured goods shipped by air would be relatively small and that the other modes would predominate as they are the modes utilized for intraregional transport. This finding is dramatically illustrated in Figure 1-1 (Reference 1-2) which compares the average length of haul by mode for the 6-year period, 1970-1975.

Several other approaches were considered in an attempt to develop major domestic commodity networks but without success. It was therefore decided to concentrate effort on the major air networks with emphasis on medium and long range. These networks are discussed in the following paragraphs.

Top 10 markets: In the Fall of 1967, Douglas executives arranged a meeting in their Washington D.C. offices which was attended by representatives of a majority of the U.S. domestic trunk carriers. The purpose of the meeting was to determine if the carriers could agree to furnish Douglas with the pounds of freight traffic carried between the various city-pair markets being served.

It was decided that each participating carrier would supply traffic for the fourth quarter of 1967. Douglas in turn would produce a pilot report

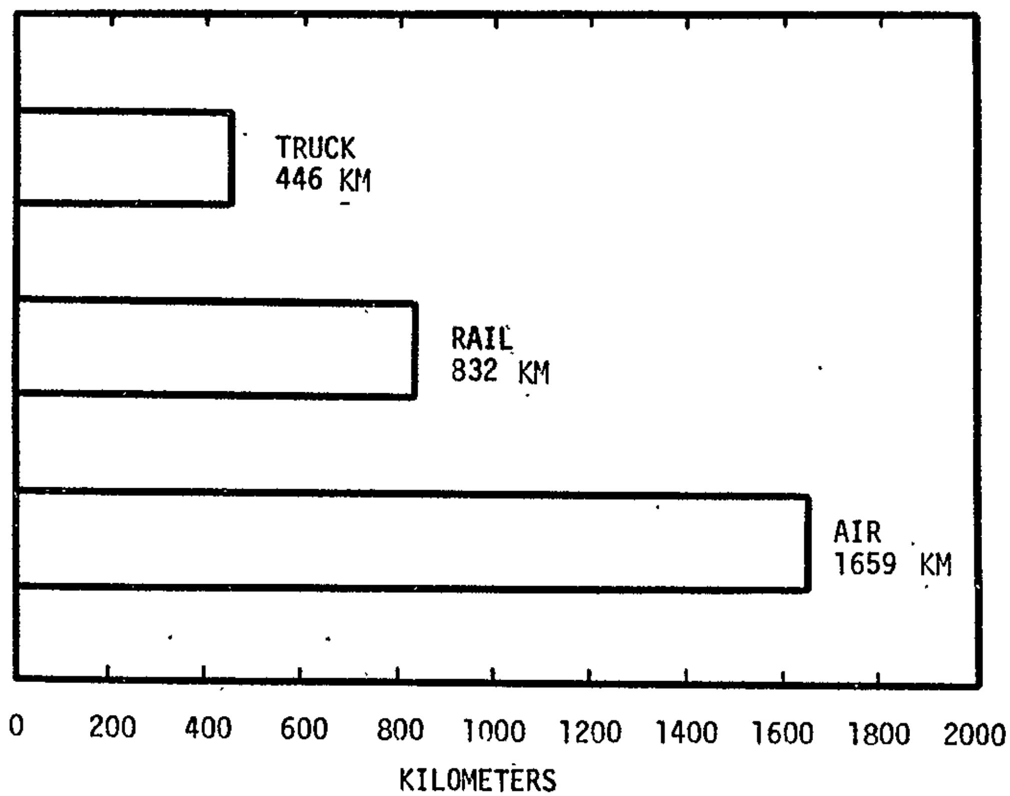


Figure 1-1. Average Length of Domestic Haul by Transportation Mode, 1970-1975
(6-Year Average)

which would show: (1) the total pounds carried for each city-pair reported, (2) each carrier market share, (3) the top 1000 city-pair markets ranked by tons and ton miles, (4) the top 100 origin cities ranked by tons and ton-miles generated, and, (5) the top destination cities ranked by tons.

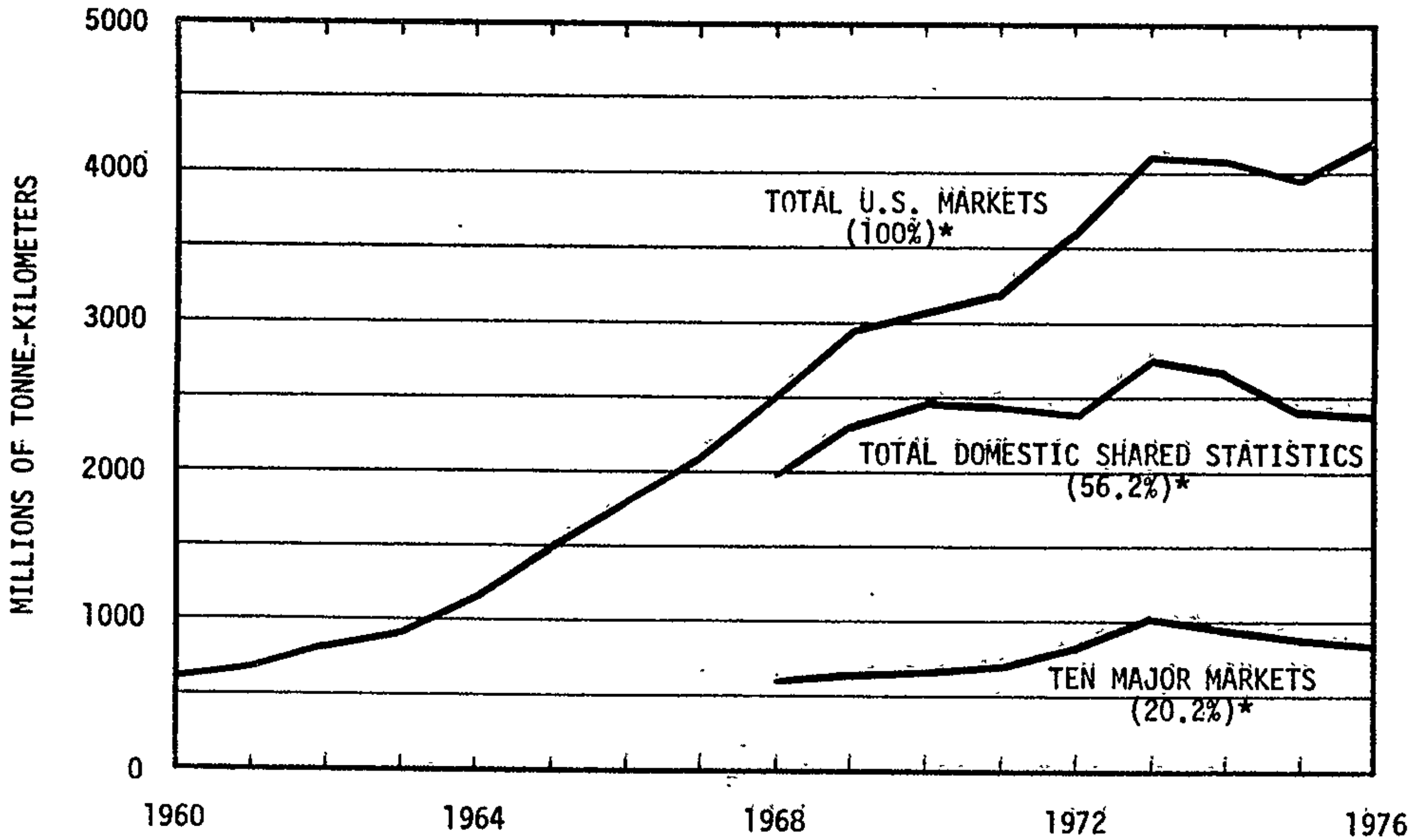
This pilot report was produced in the Spring of 1968 and as a result, a majority of the carriers agreed to send Douglas their freight traffic statistics on a quarterly basis. The program is called the "Douglas Domestic Shared Statistics" (DDSS) (Reference 1-3) and has been produced quarterly with an annual summary since 1968. The 1976 annual summary was used to select the top domestic markets in the United States for further analysis.

The top markets (matching city-pairs) reported in 1976 are as follows:

City-Pair	Rank	Tonnes
LAX-NYC	1	50 580
SFO-NYC	2	33 299
LAX-CHI	3	30 711
NYC-LAX	4	29 998
NYC-CHI	5	24 825
CHI-NYC	6	21 222
CHI-LAX	7	18 272
NYC-SFO	8	17 826
SFO-CHI	9	17 538
CHI-SFO	10	11 375
Total Tonnes		255 646

In 1976, approximately 10 000 markets were reported. The air freight transported in these markets amounted to 981 173 tonnes. Traffic moving in the top 1000 city-pair markets amounted to 255 646 tonnes or 26 percent of the 1976 total traffic flow as reported in DDSS.

In Figure 1-2 the total tonne-kilometers for the domestic market (Reference 1-37) is compared to total (DDSS) and to the selected city-pairs (Reference 1-3). Total (DDSS) and the 10 selected city-pairs represent 56 and 20 percent, respectively of the total domestic market in 1976. These percentages vary from those previously stated because the base is now total airfreight rather than the total as reported by participating members.



* Percentages are for 1976.

Figure 1-2. Comparison of Total Airfreight and Domestic Shared Statistics in U.S. Scheduled Domestic Operations, 1960-1976

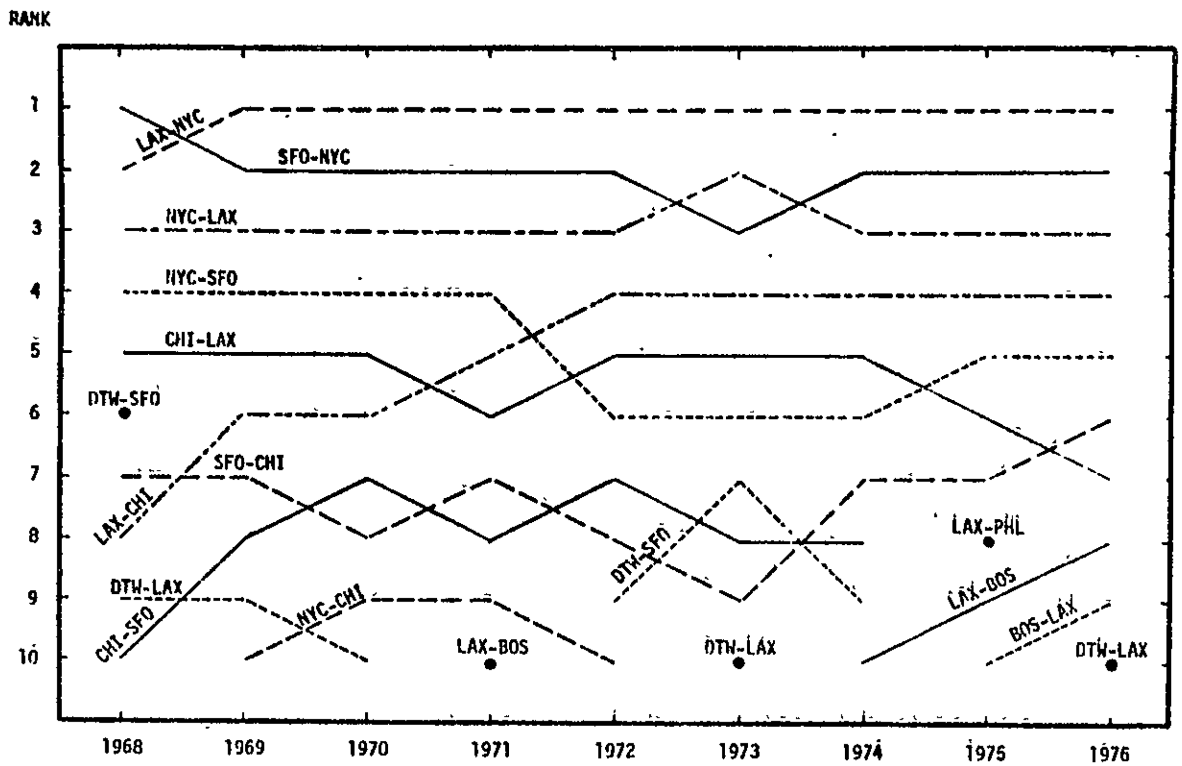
In 1976, the 10 major markets accounted for 36 percent of total (DDSS) tonne-kilometers. Over the time frame considered, this percentage has ranged from 27 percent in 1970 to 37 percent in 1973. The average percentage for the 9 years has been 33 percent.

Figure 1-3 (Reference 1-3) indicates the comparative dominance of certain city-pairs in total domestic air cargo flow. During the 9-year period studied, three city-pairs (LAX-NYC, SFO-NYC, NYC-LAX) have held either first, second, or third position in the rank order of leadership. The reasons for this include the facts that all three cities are major Standard Metropolitan Statistical Areas; they are large population centers, important as both production and consumption areas; all three cities are major domestic distribution centers; and each of the cities is a major port for international trade with both surface (ships) and air modes being utilized.

The absence of city-pairs representing airfreight traffic flow to/from southern cities and northern or western cities is apparent in the listing of the top 10 city-pairs. Analysis of this situation included tabulation of air traffic flow among 270 southern cities and cities in the northern and western areas as reported in the 1976 annual summary of DDSS. This analysis showed the total tonnage to/from the 270 cities to be only 94 300 tonnes or 9.6 percent of total (DDSS).

Although there has been significant population and industrial growth in southern states during the last decade, geographic proximity to northern markets and limited demand for air-transported commodities from western states has greatly limited air penetration of the predominating surface modes.

North-South airfreight has indeed greatly increased from 1962 to 1976. For example, airfreight activity at Atlanta has increased 1050 percent. Other major Southern cities, Dallas, Houston, New Orleans, and Miami, have experienced large percentage increases in total activity,(freight, mail and express uplifted and discharged), as shown in Table 1-1 and by region in Figure 1-4. The data presented in Table 1-1 are taken from two government publications:



Note: CHI-SFO, dropped out of top 10 in 1975, 1976
LAX-BOS, first appears in 1971 then again in 1974, 1975, 1976
DTW-SFO, dropped out of top 10 in 1969, 1970; 1971, 1975, 1976
DTW-LAX, dropped out of top 10 in 1971, 1972; 1974; 1975
LAX-PHL, appears only in 1975

Figure 1-3. Cargo/Logistics Airlift Systems Study (CLASS) - 10 Top Domestic City-Pairs (Ranked by Tonne-Kilometers - 1968-1976)

TABLE 1-1
AIRFREIGHT ACTIVITY AT MAJOR U.S. AIRPORTS
(THOUSANDS OF TONNES)

Region and Airport	1962		1976		Percent Change
	Tonnes	Percent Total	Tonnes	Percent Total	
West South Central					
Dallas	33	2.4	128	3.1	287
Houston	10	0.7	71	1.7	610
New Orleans	5	0.4	26	0.6	420
Total	48	3.5	225	5.4	368
South Atlantic					
Miami/Ft. Lauderdale	110	8.0	200	4.9	82
Atlanta	18	1.3	207	5.1	1050
Washington D.C.	13	0.9	51	1.3	292
Total	141	10.2	458	11.3	223
East North Central					
Chicago	225	16.3	633	15.5	181
Cleveland	30	2.2	93	2.3	210
Detroit	72	5.2	134	3.3	186
Total	327	23.7	860	21.1	163
Pacific					
Los Angeles	186	13.5	608	15.0	227
San Francisco	138	10.0	393	9.6	185
Seattle	47	3.4	265	6.5	464
Total	371	26.9	1266	31.1	241
Middle Atlantic					
New York/Newark	378	27.4	712	17.5	88
Philadelphia	26	2.0	104	2.6	300
Pittsburgh	8	0.6	32	0.8	300
Total	412	30.0	848	20.9	106
New England					
Boston	36	2.6	147	3.6	308
Total	36	2.6	147	3.6	308

TABLE 1-1. - Concluded

AIRFREIGHT ACTIVITY AT MAJOR U.S. AIRPORTS
(THOUSANDS OF TONNES)
(Enplaned and Deplaned, All Services)

Region and Airport	1962 Tonnes	1962 Percent Total	1976 Tonnes	1976 Percent Total	Percent Change
West North Central					
Minneapolis/St. Paul	13	0.9	86	2.1	562
Kansas City	9	0.7	30	.7	233
St. Louis	11	0.8	51	1.3	364
Total............	33	2.4	167	4.1	406
Mountain					
Denver	10	0.7	102	2.5	920
Total..........	10	0.7	102	2.5	920
GRAND TOTAL........	1378	100.0	4073	100.0	196

- Enplaned/deplaned ratio - U.S. Department of Transportation, "Projection of Cargo Activity at U.S. Air Hubs", Report No. SS-211-U1-4, September 1976.

- Enplaned Freight - FAA, U.S. Department of Transportation, "Airport Activity Statistics of Certificated Route Air Carriers", 1962-1976.

Percentage increases of airfreight activity at Southern airports has had comparatively little effect on the overall regional percentage distribution.

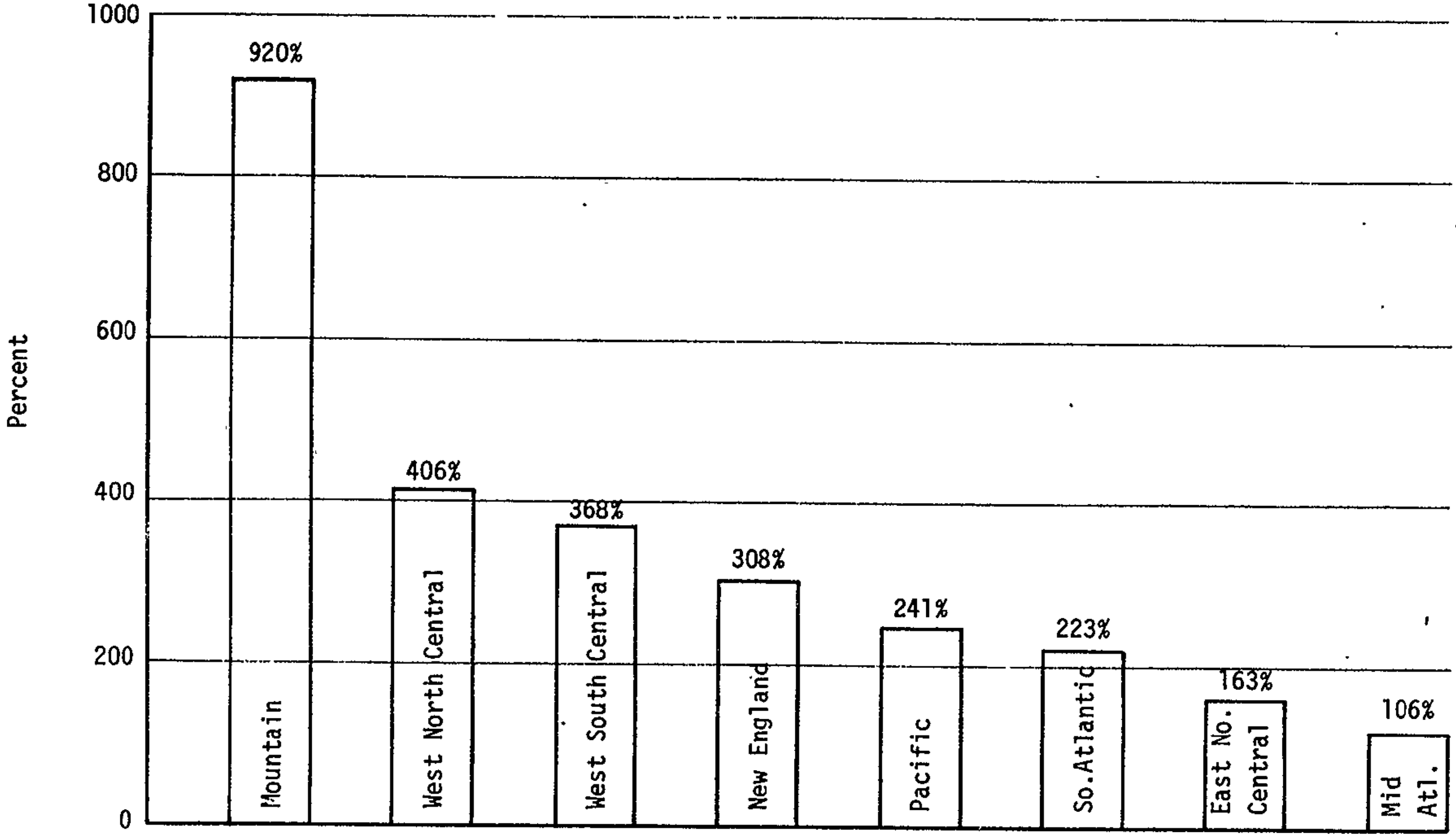


Figure 1-4. Percent Change in Airfreight Activity by Domestic Region, 1972 - 1976
(Enplaned and Deplaned, All Services)

The Pacific (LAX-SFO), Middle Atlantic (NYC), and East North Central (CHI) regions accounted for 81 percent of the total airfreight activity in 1962 and 73 percent in 1976 (Figure 1-5).

The 20 major U.S. domestic airports and the regions in which they are located is depicted geographically in Figure 1-6.

Additional analysis of Figure 1-3 indicates that other city-pairs in the top 10 have not experienced the stability of the three ranking city-pairs. The following observations and possible explanations indicate cargo movement aspects of the economic-based variations of the city-pairs.

- NYC-SFO - decreased from fourth to sixth place and currently has risen to fifth place. One possible explanation is the comparatively new capability of SFO industry to supply local major producers of electronic equipment and farm machinery. Another possible explanation is international in scope and indicates the increased amount of imports from Pacific ports.
- CHI-LAX - decreased from fifth to sixth place and now is ranked seventh. The explanation is similar to that provided for NYC-SFO, i.e., growth of California industry and increased imports from Pacific ports.
- DTW-SFO - In 1968, Detroit was in sixth place, then dropped from the top 10 completely for the years 1969-71. It was back in 1972 and 1973 holding ninth to seventh places. In 1975 and 1976, the city-pair was once again out of the top 10. The city-pair DTW-LAX is similar to DTW-SFO in that it was in the top 10 for some years and then drops out completely. This city-pair has never held a rank higher than ninth and is currently in 10th place. As Detroit's major production effort is in automobiles and automobile parts and accessories, it would seem obvious that surface transportation (motor carrier) is a prime competitive factor in the transportation of auto parts and accessories which could possibly be an air-transportable commodity.
- LAX-CHI - This city-pair has shown a steady increase in rank from eighth place in 1968 to fourth place in 1972 which it currently maintains. The increased production capacity of the area is

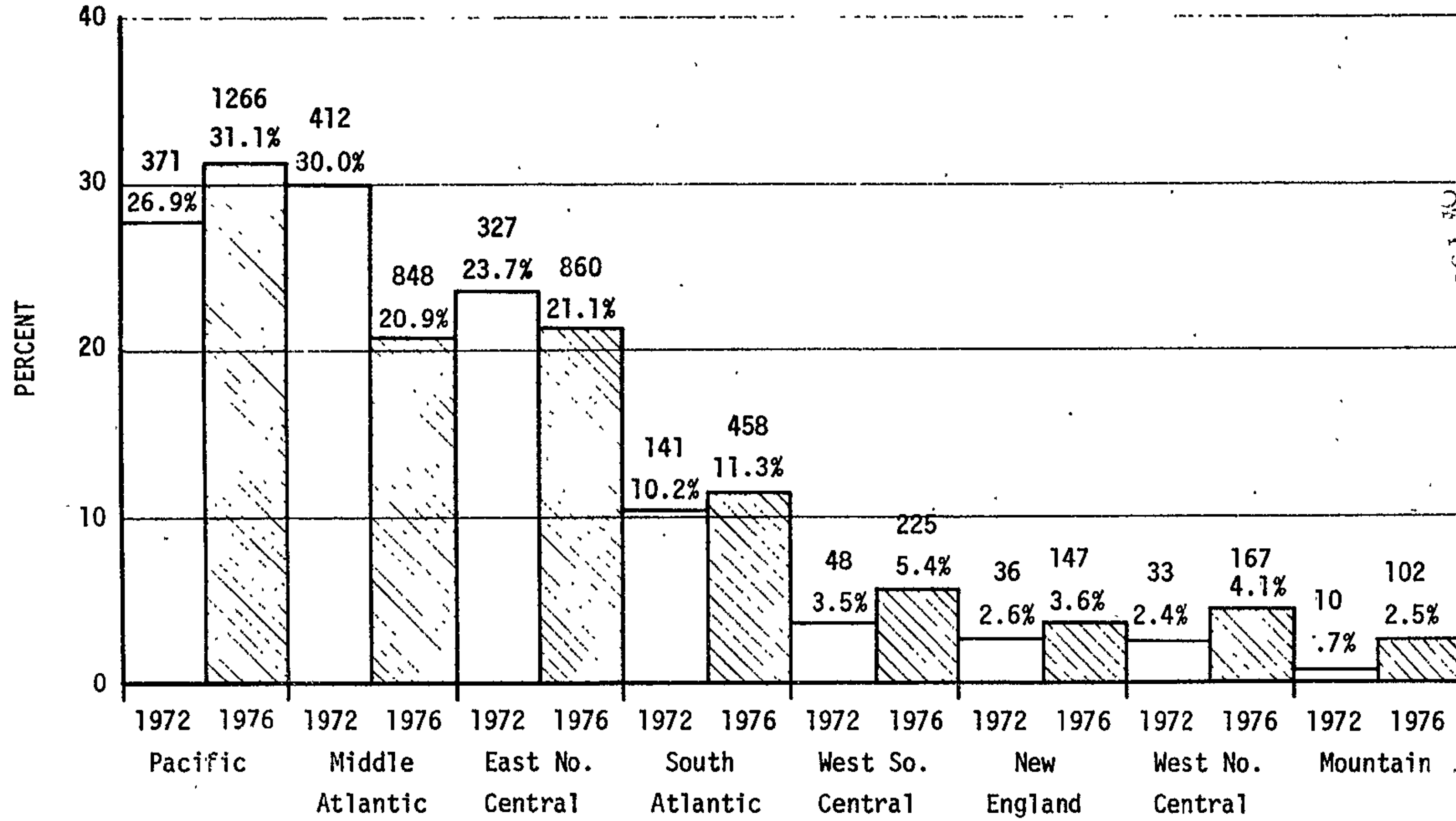
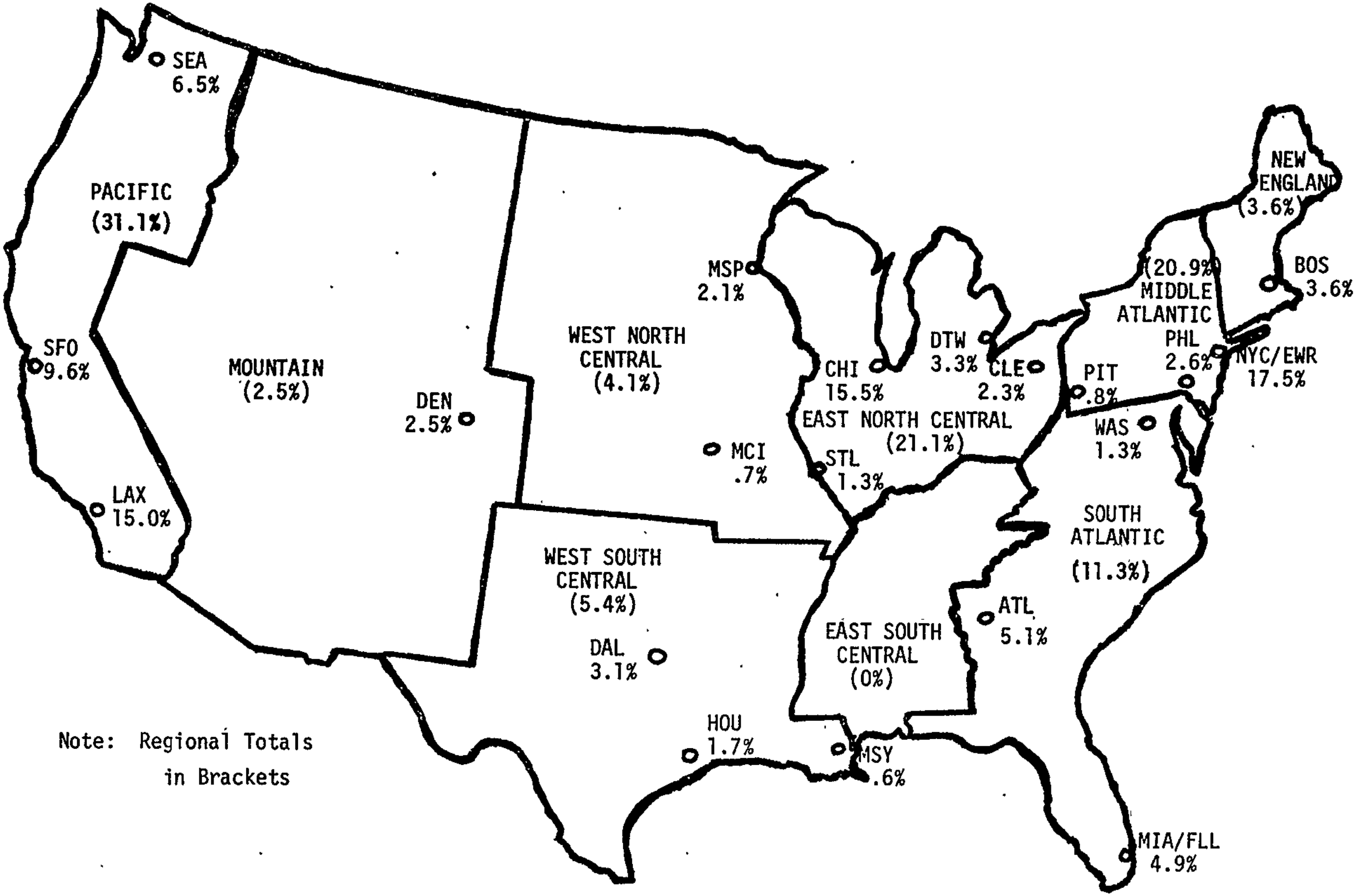


Figure 1-5. Percent of Total and Quantity of Airfreight Activity by Domestic Region, 1972 - 1976 (Thousands of Tonnes)



Note: Regional Totals in Brackets

Figure 1-6. Percentage Distribution of Air Freight Activity at Major U.S. Domestics Airports, 1976 (Total Tonnes 20 Airports - 4,073,000) undoubtedly an influencing factor in this increase. In addition, the transportation of fresh fruits and vegetables from the area has increased.

Seasonal patterns: Seasonal patterns as shown for fourth quarter 1975 through first quarter 1977 in Table 1-2 (Reference 1-3), are not of a great magnitude when considering the total 10 city-pairs. However, the individual city-pairs vary considerably from quarter to quarter. Of the six quarters analyzed, the largest decreases take place between the fourth quarter 1975 and first quarter 1976. This is true not only of the total 10 city-pairs, but also for certain of the individual city-pairs. The decreases range from 1.9 percent for NYC-CHI to 25.2 percent for SFO-NYC and 28.2 percent for SFO-CHI. Part of these decreases for 1975-1976 can be attributed to the economic recession of that period. This is not the entire explanation as similar, if less drastic, decreases occur for the same quarters in 1976-1977. A possible reason for the decreases that occur for SFO-NYC and SFO-CHI would be a lessening of the demand for fresh fruits after the holidays. Investigation of this possibility indicates that this was not a causal factor. From the publication "Air Shipments of Fresh Fruits and Vegetables" by the United States Department of Agriculture (Reference 1-4), data were obtained which show that shipments of these commodities actually increased slightly to NYC and CHI for the quarter being considered. Another possible reason for the decrease is the lessening of inventories after holiday purchases and also for annual store inventory records.

There is an increase for the total 10 city-pairs between first and second quarter, 1976 and between the third and fourth quarters, 1976. During these periods, there was a general purchasing increase in both the consumer and industrial sectors of the economy.

Figure 1-7 indicates comparatively small variations by season. However, analysis of the seasonal traffic flow by individual city-pairs provides the following observations:

- LAX-CHI - Peaks in the second quarter which corresponds with this quarter being the most important in regard to shipments of fresh fruits and vegetables to Chicago (Figure 1-8).

TABLE 1-2

SEASONAL PATTERNS OF TOP 10 DOMESTIC CITY-PAIRS, 1975-1977

City-Pair	1975	1976								1977	
	Fourth Quarter (Tonnes)	First Quarter (Tonnes)	Percent Change	Second Quarter (Tonnes)	Percent Change	Third Quarter (Tonnes)	Percent Change	Fourth Quarter (Tonnes)	Percent Change	First Quarter (Tonnes)	Percent Change
CHI-LAX	4 677	4 481	(4.2)	4 287	(4.3)	4 456	3.9	5 046	13.2	5 092	0.9
LAX-CHI	7 931	7 962	0.4	8 099	1.7	7 758	(4.2)	7 632	(1.6)	6 881	(9.8)
CHI-NYC	5 780	5 300	(8.3)	5 561	4.9	4 798	(3.7)	5 564	16.0	5 056	(9.1)
NYC-CHI	6 430	5 664	(1.9)	6 021	6.3	6 052	0.5	7 088	17.1	5 435	(23.3)
CHI-SFO	3 197	2 694	(5.7)	2 768	2.8	2 849	2.9	3 064	7.6	3 024	(2.3)
SFO-CHI	5 030	3 613	(28.2)	5 357	48.3	4 536	(15.3)	4 033	(11.1)	3 209	(20.4)
LAX-NYC	13 438	12 041	(10.4)	14 357	19.2	12 050	(16.1)	12 133	0.7	13 376	10.2
NYC-LAX	8 927	8 203	(8.1)	7 222	(12.0)	7 206	(0.2)	8 130	12.8	7 586	(6.7)
NYC-SFO	5 785	4 642	(19.4)	4 097	(11.7)	4 241	3.5	4 845	14.2	4 754	(1.9)
SFO-NYC	9 280	6 945	(25.2)	10 296	48.3	8 790	(14.6)	7 268	(17.3)	6 752	(7.1)
Total	70 448	61 545	(12.6)	68 065	10.6	60 736	(10.8)	64 803	6.7	61 165	(5.6)

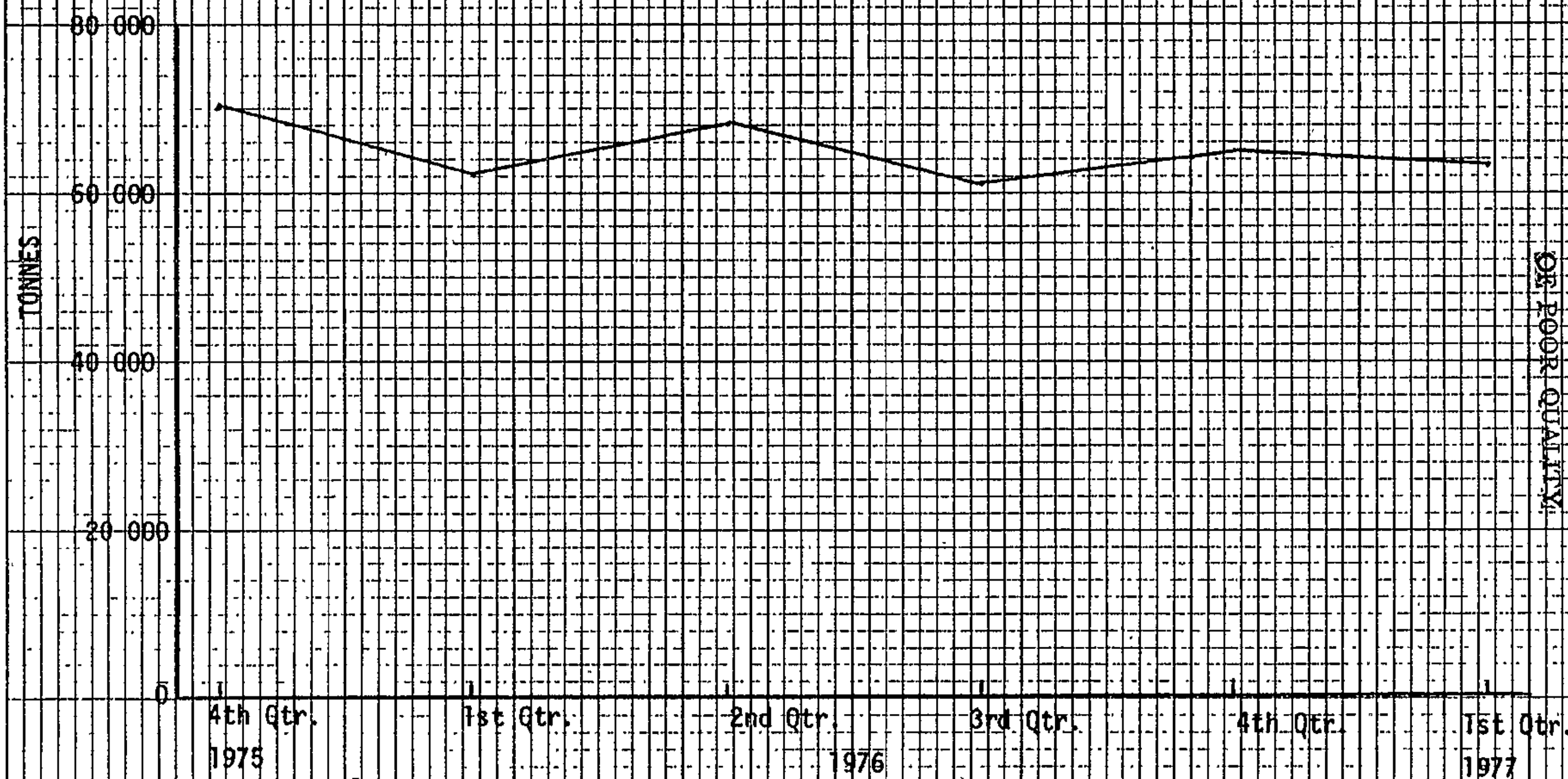


Figure 1-7. Seasonal Pattern of Total Top 10 City-Pairs, 1975 - 1977

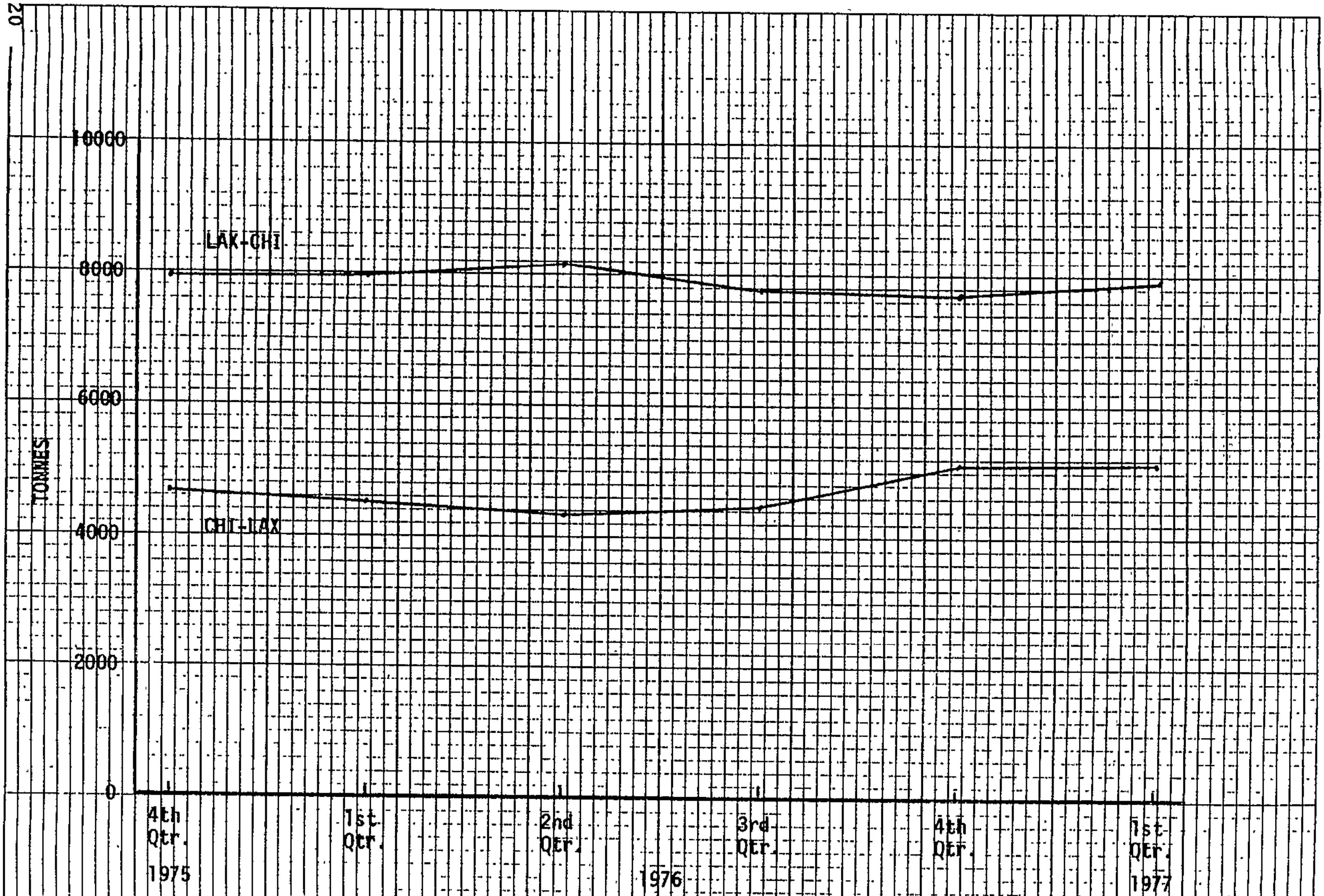


Figure 1-8. Seasonal Pattern of CHI-LAX/LAX-CHI, 1975 - 1977

- CHI-LAX - Peaks in the fourth quarter which is probably attributable to Christmas inventory stocking and individual shipments (Figure 1-8).
- NYC-CHI/CHI-NYC - Again, the peak occurs in the fourth quarter which is attributable to holiday inventory buildup (Figure 1-9).
- SFO-CHI/CHI-SFO - The SFO shipments to CHI greatly increase during the second quarter as they did for LAX and the reason is the same -- fresh fruits and vegetables. A steady decrease is experienced for this pair for each quarter thereafter (Figure 1-10).
- LAX-NYC/NYC-LAX, SFO-NYC/NYC-SFO - For both of these city-pairs, a similar seasonal pattern occurs, i.e., a peaking from the produce regions in the second quarter for east-bound flights and a fourth quarter increase for west-bound flights (Figures 1-11 and 1-12).

Freight carried, capacity offered, and frequencies: The Official Airline Guide (OAG) (Reference 1-5) is utilized to determine the kilos offered from any origin city in the world based upon the aircraft type being flown. The months of February and August are used and are considered representative of typical winter and summer schedules.

Aircraft schedules are calculated upon the basis of the cubic capacity available and on assumed average density of the on-board loads. The following density assumptions apply to the aircraft type serving the selected markets:

Aircraft Type	Assumed Average Density
Freight (AF)	163.4 kg/m^3
Passenger (PAX)	
Bulk	115.3
LD3 Container	140.9
LD7 Container	163.4

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Cargo capacity for passenger aircraft is based upon an average number of seats for each passenger aircraft type. Assuming 100-percent passenger load factor, 0.127 cubic meters of capacity are deducted for each seat and allocated to passenger baggage. The residual volume is salable capacity available for cargo.

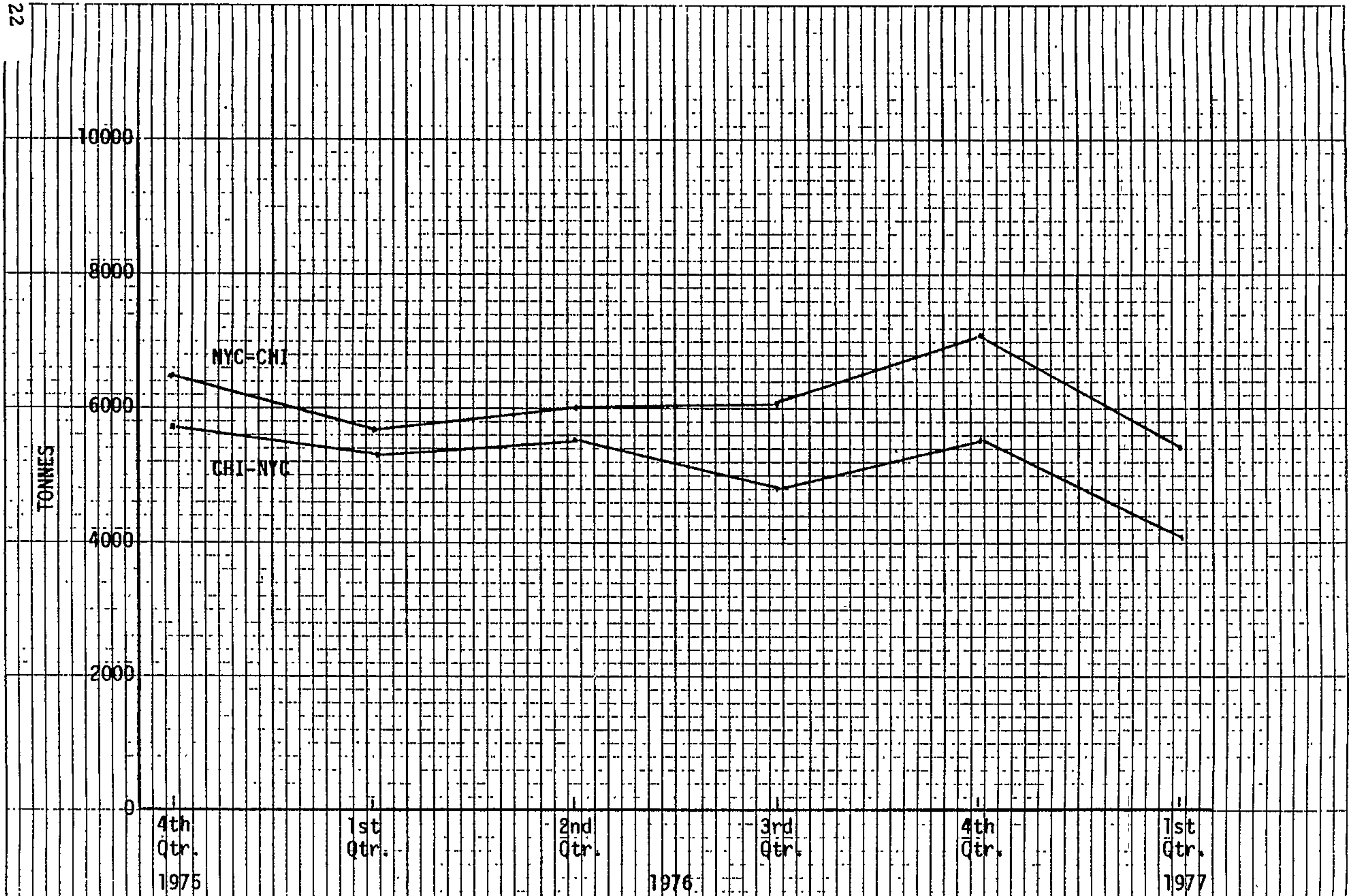

Figure 1-9. Seasonal Pattern of CHI-NYC/NYC-CHI, 1975 - 1977

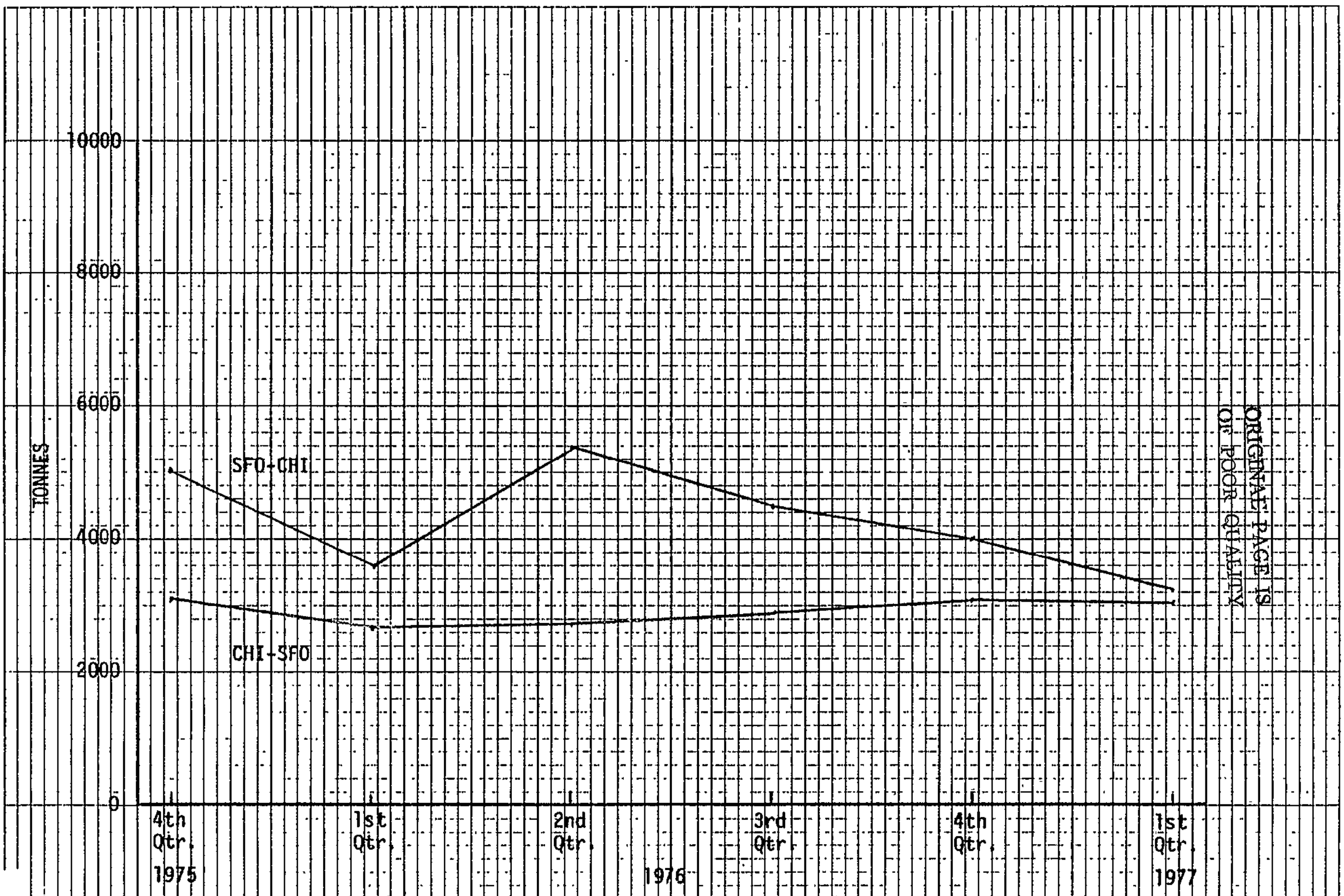

Figure 1-10. Seasonal Pattern of CHI-SFO/SFO-CHI, 1975 - 1977

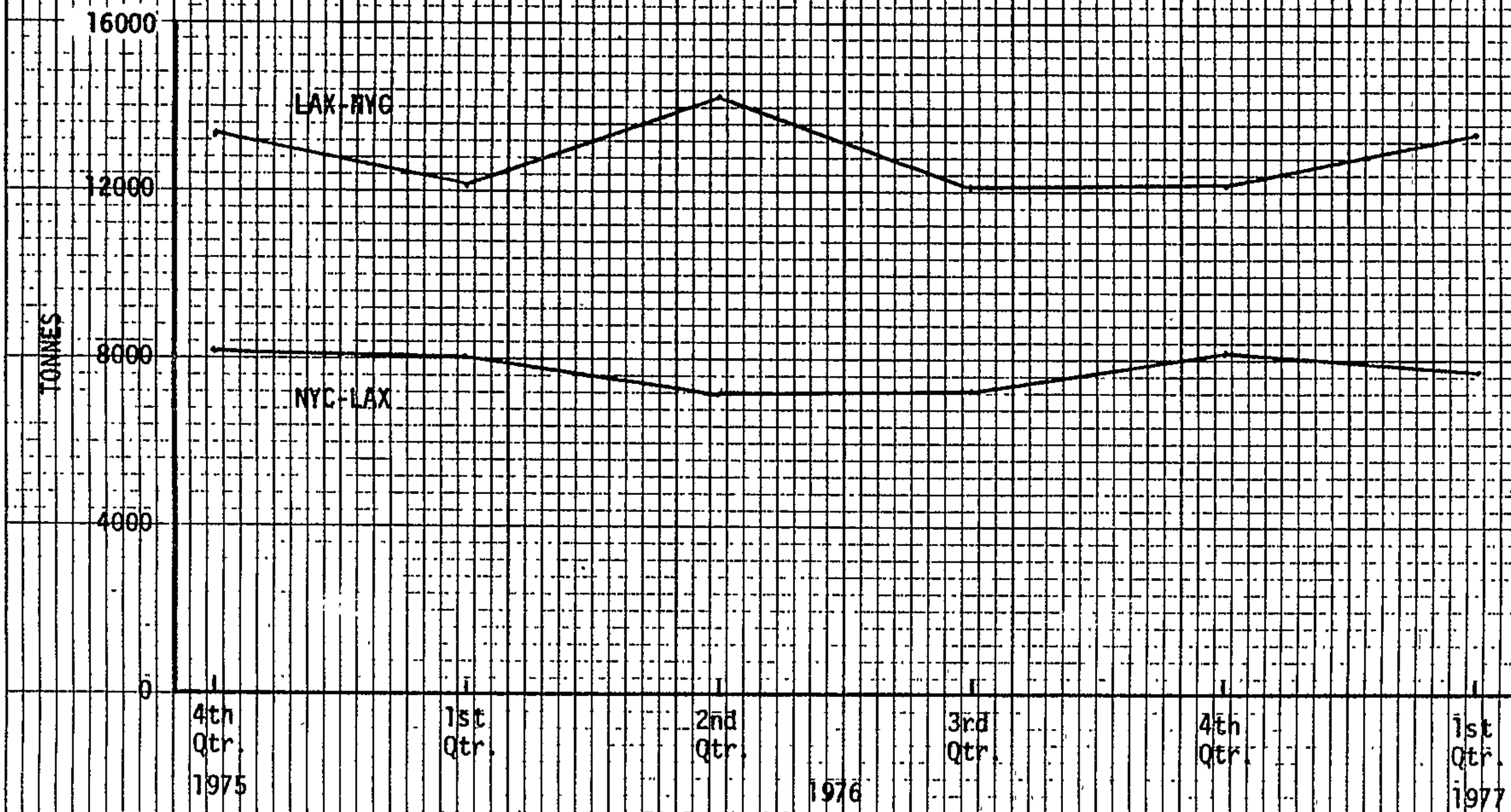

Figure 1-11. Seasonal Pattern of LAX-NYC/NYC-LAX, 1975 - 1977

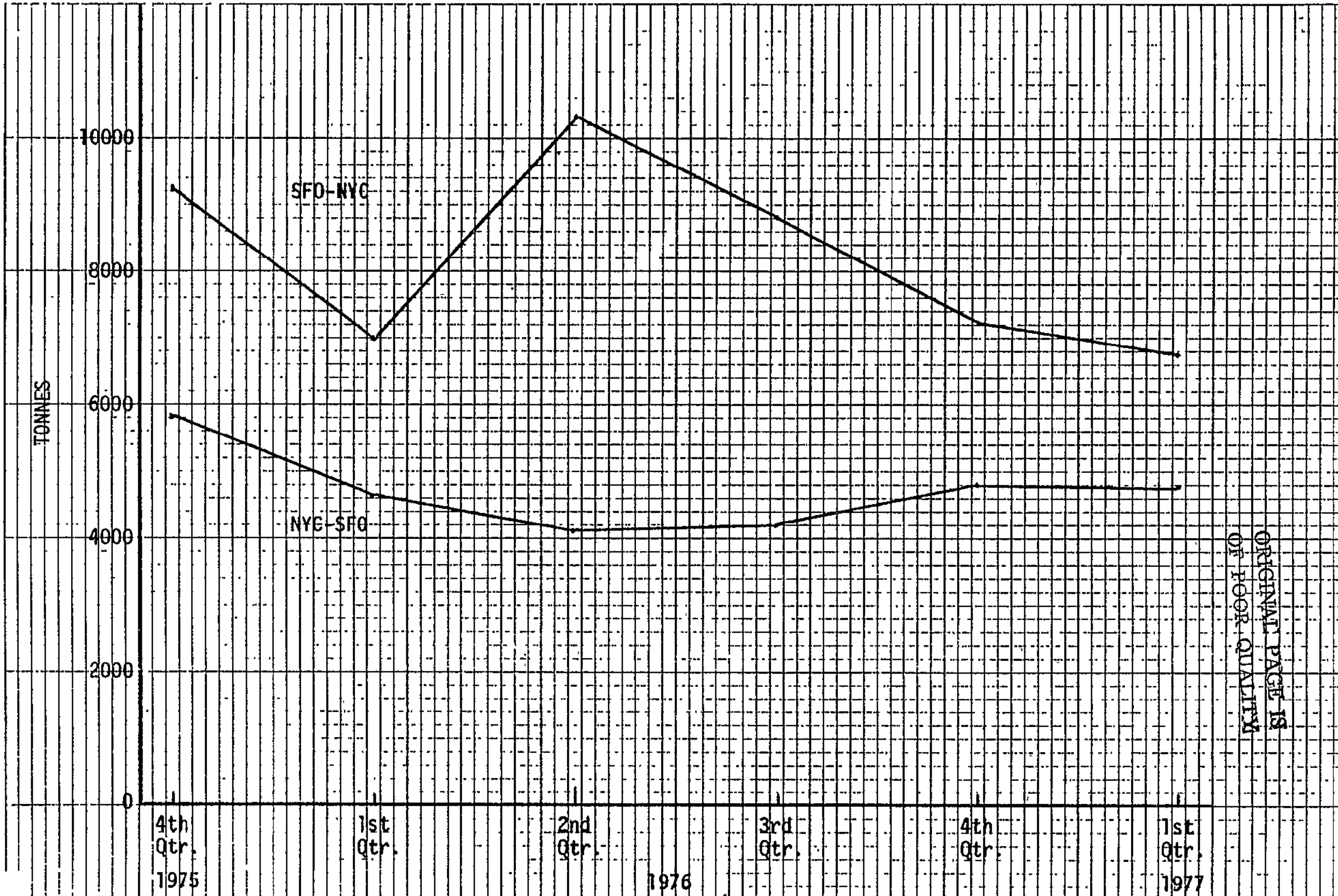

Figure 1-12. Seasonal Pattern of NYC-SFO/SFO-NYC, 1975 - 1977

Lower-hold freight payload capacity based upon average number of passenger seats and 100-percent passenger load factor for various aircraft types is as follows:

Aircraft Type	Payload (kilograms)
737-200	1 556
DC-9-30	1 629
DC-9-50 (supplemental fuel)	1 934
DC-9-50 (without)	2 397
727-200	2 715
DC-10-30 (lower galley)	3 784
L-1011	5 045
B747 (lower galley)	5 045
A300	8 199
DC-10-30 (upper galley)	11 352
B747 (upper galley)	12 614

Freighter aircraft capacities are based upon available palletized main deck volume at 163.4 kg/m^3 and applicable container or bulk densities for the lower holds. The payload of various all-freight aircraft is as follows:

Aircraft Type	Payload (kilograms)
DC-8-50AF	35 100
DC-8-62AF	29 600
DC-8-63AF	45 400
B707-302C	31 700
B747-200C	99 600
B747-200F	99 600
B747-100RF	90 700

In regards to capacity offered, wide-body passenger aircraft were serving all of the markets during this time period. Douglas DC-8F and Boeing 707F were the freighter aircraft used to serve these markets. In 1976 the B747F was introduced by American, Flying Tigers, and Northwest and was used to serve the markets as shown below:

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Market	Airline
CHI-NYC	AA, FT, NW
NYC-CHI	FT, NW
NYC-LAX	AA
NYC-SFO	AA
SFO-CHI	AA

Both Flying Tigers and Northwest eastbound and westbound itineraries used Asian points as origins or destinations so these services were primarily for overseas traffic.

A series of tabulations, Tables 1-3 through 1-6 (References 1-3 and 1-5), were prepared in order to compare the reported traffic for the 10 major markets from 1972 through 1976 with the representative frequencies of service and capacity offered for the same time period. Weekly frequencies and the annual percent change for passenger and all-freighter aircraft were calculated and are shown in Tables 1-7 and 1-8 (Reference 1-5). A summary table, Table 1-9 (References 1-3 and 1-5) was prepared which illustrates the percentage change from year to year in traffic, weekly frequencies, and capacity.

From the data in this summary table, Figures 1-13 through 1-23 (References 1-3 and 1-5) were prepared. Figure 1-3 provides a comparison of capacity offered and quantity carried for the combined total of selected city-pairs during the 5-year period 1972-1976. The same comparison is made for individual city-pairs in Figures 1-14 through 1-23 (References 1-3 and 1-5).

In 1973 with the exception of the New York-Chicago-New York markets, traffic growth was strong. However, the combination of the 1973 increase in oil prices and the economic recession during 1974 and 1975 resulted in deterioration in traffic carried and services offered. Some recovery was experienced in the Chicago markets but with the exception of the markets served by the B747F, a steady decline in all-freighter services over the past few years seems apparent.

Major commodities transported by air. - Commodities transported by air have historically consisted of those which are characterized by high-value, urgency, perishability, and small shipments.

TABLE 1-3

TOTAL AIR CARGO SERVICES
PERCENT CHANGE OF QUANTITY CARRIED, 3RD QUARTER 1972-1976
FOR SELECTED CITY PAIRS

City Pair	3rd Qtr 1972 Tonnes	3rd Qtr 1973 Tonnes	Percent Change	3rd Qtr 1974 Tonnes	Percent Change	3rd Qtr 1975 Tonnes	Percent Change	3rd Qtr 1976 Tonnes	Percent Change
CHI-LAX	6 899	8 225	19	6 964	(15)	4 103	(41)	4 456	9
LAX-CHI	7 763	8 818	14	8 083	(8)	7 090	(12)	7 758	9
CHI-NYC	5 329	4 939	(7)	4 486	(9)	4 634	3	4 798	4
NYC-CHI	6 444	5 672	(12)	5 199	(8)	5 032	(3)	6 051	20
CHI-SFO	3 792	5 268	39	4 260	(19)	2 697	(37)	2 848	6
SFO-CHI	4 607	5 431	18	6 089	12	4 182	(31)	4 536	8
LAX-NYC	11 922	13 715	15	10 578	(23)	12 648	20	12 049	(5)
NYC-LAX	7 929	9 389	18	6 573	(30)	7 294	11	7 205	(1)
NYC-SFO	4 543	5 781	27	4 258	(28)	4 981	20	4 241	(15)
SFO-NYC	8 134	8 760	8	8 844	0	9 535	8	8 790	(8)
	67 362	75 997	13	65 234	(14)	62 196	(5)	62 73[illegible]	0

TABLE 1-4

ESTIMATED AIR CARGO CAPACITY OFFERED

City Pair	Date and Percent Change								
	8/72 1000 kg	8/73 1000 kg	%	8/74 1000 kg	%	8/75 1000 kg	%	8/76 1000 kg	%
CHI-LAX	3 283	3 555	8	2 995	(16)	3 026	1	2 856	(6)
LAX-CHI	3 185	3 116	(2)	2 951	(5)	3 106	5	2 728	(12)
CHI-NYC	4 337	4 572	5	4 047	(1)	3 992	(1)	4 146	4
NYC-CHI	4 489	4 564	2	4 219	(8)	4 098	(3)	4 430	8
CHI-SFO	1 980	2 507	27	2 275	(9)	2 221	(2)	1 837	(17)
SFO-CHI	2 282	2 610	14	2 315	(11)	2 753	19	2 269	(18)
LAX-NYC	3 930	4 123	5	3 756	(9)	3 092	(18)	3 261	5
NYC-LAX	3 705	3 987	7	3 575	(10)	3 953	11	3 855	(2)
NYC-SFO	3 594	3 551	(1)	3 214	(9)	3 755	17	3 634	(3)
SFO-NYC	4 206	4 610	10	3 479	(25)	3 997	15	3 835	(4)
	34 991	37 186	6	32 826	(13)	33 993	4	32 851	(4)

TABLE 1-5

ESTIMATED CAPACITY OFFERED - PASSENGER SERVICE

City Pair	Date and Percent Change								
	8/72 1000 kg	8/73 1000 kg	%	8/74 1000 kg	%	8/75 1000 kg	%	8/76 1000 kg	%
CHI-LAX	1 887	2 140	13	1 716	(20)	1 804	5	1 881	4
LAX-CHI	1 822	1 898	4	1 755	(8)	2 021	13	1 953	(3)
CHI-NYC	1 874	2 200	17	1 916	(13)	1 942	0	1 851	(5)
NYC-CHI	1 786	1 996	11	1 756	(14)	1 745	0	1 730	0
CHI-SFO	681	837	19	809	(3)	983	22	785	(25)
SFO-CHI	724	875	20	925	6	1 101	19	902	(22)
LAX-NYC	1 561	1 800	15	1 447	(24)	1 564	8	1 428	(10)
NYC-LAX	1 485	1 585	7	1 194	(33)	1 445	21	1 413	(2)
NYC-SFO	1 169	1 150	(2)	1 271	11	1 457	15	1 368	(7)
SFO-NYC	1 220	1 168	(4)	1 121	(4)	1 386	24	1 282	(8)
	14 209	15 649	9	13 910	(13)	15 446	11	14 592	(6)

TABLE 1-6

ESTIMATED CAPACITY OFFERED - ALL FREIGHTER SERVICES

City Pair	Date and Percent Change								
	8/72 1000 kg	8/73 1000 kg	%	8/74 1000 kg	%	8/75 1000 kg	%	8/76 1000 kg	%
CHI-LAX	1 396	1 415	1	1 279	(4)	1 223	(9)	975	(20)
LAX-CHI	1 363	1 218	(11)	1 196	(2)	1 085	(9)	755	(30)
CHI-NYC	2 463	2 372	(4)	2 130	(10)	2 049	(4)	2 295	12
NYC-CHI	2 704	2 569	(5)	2 462	(3)	2 353	(4)	2 700	15
CHI-SFO	1 299	1 670	29	1 466	(12)	1 239	(15)	1 052	(15)
SFO-CHI	1 558	1 735	11	1 390	(20)	1 652	19	1 367	(17)
LAX-NYC	2 369	2 324	(2)	2 309	(1)	1 528	(34)	1 833	20
NYC-LAX	2 220	2 393	8	2 381	(1)	2 508	5	2 442	(3)
NYC-SFO	2 425	2 400	(1)	1 942	(19)	2 297	18	2 266	(1)
SFO-NYC	2 986	3 442	15	2 357	(32)	2 608	11	2 553	(2)
	20 783	21 538	4	18 912	(12)	18 542	(2)	18 258	(2)

TABLE 1-7

WEEKLY FREQUENCIES - PASSENGER AND ALL-FREIGHTER SERVICES FOR SELECTED MARKETS 1972-1976 (Month of August)

Market	1972		1973		1974		1975		1976	
	PAX	AF	PAX	AF	PAX	AF	PAX	AF	PAX	AF
CHI-LAX	273	42	327	46	284	43	266	41	298	33
LAX-CHI	294	41	292	41	292	40	346	37	298	26
CHI-NYC	649	80	670	85	540	74	524	54	509	58
NYC-CHI	621	87	665	91	508	87	502	71	499	82
CHI-SFO	168	48	178	61	156	52	157	45	154	36
SFO-CHI	162	53	179	64	170	48	184	44	182	36
LAX-NYC	289	69	303	75	268	78	256	53	253	62
NYC-LAX	277	71	264	83	212	77	235	71	235	70
NYC-SFO	218	78	233	80	212	63	230	67	219	64
SFO-NYC	225	90	227	116	191	80	219	72	217	69

TABLE 1-8

PERCENT CHANGE IN WEEKLY FREQUENCIES - PASSENGER AND ALL-FREIGHTER SERVICES FOR SELECTED MARKETS 1972-1976 (Month of August)

Market	1973		1974		1975		1976		1972-1976	
	PAX	AF	PAX	AF	PAX	AF	PAX	AF	PAX	AF
CHI-LAX	20	10	(13)	(7)	(6)	(5)	12	(20)	9	(21)
LAX-CHI	(1)*	0	0	(2)	18	(7)	(14)	(30)	1	(27)
CHI-NYC	3	(6)	(19)	(13)	(3)	(27)	(3)	7	(22)	(27)
NYC-CHI	7	4	(24)	(4)	(1)	(18)	(1)	15	(20)	(6)
CHI-SFO	6	27	(12)	(15)	1	(13)	2	(20)	(8)	(25)
SFO-CHI	10	21	(5)	(25)	8	(8)	1	(18)	12	(32)
LAX-NYC	5	9	(12)	4	(4)	(32)	(1)	17	(12)	(10)
NYC-LAX	(5)	17	(20)	(7)	11	(8)	0	(1)	(15)	(1)
NYC-SFO	7	3	(9)	(21)	8	6	(5)	(4)	0	(18)
SFO-NYC	1	29	(16)	(31)	15	(10)	1	(4)	(4)	(23)

*Numbers in parentheses indicate decrease

TABLE 1-9

COMPARISON OF PERCENT CHANGE IN FREIGHT CARRIED, CAPACITY OFFERED, AND FREQUENCIES (F)/WEEK FOR SELECTED MARKETS, 1972-1976

Market	1973				1974				1975				1976			
	Freight Carried	Capacity Offered	F/Week (PAX)	F/Week (AF)	Freight Carried	Capacity Offered	F/Week (PAX)	F/Week (AF)	Freight Carried	Capacity Offered	F/Week (PAX)	F/Week (AF)	Freight Carried	Capacity Offered	F/Week (PAX)	F/Week (AF)
CHI-LAX	19	8	20	10	(15)	(16)	(13)	(7)	(41)	1	(6)	(5)	9	(6)	12	(20)
LAX-CHI	14	(2)	(1)	0	(8)	(5)	0	(2)	(12)	5	18	(3)	9	(12)	(14)	(30)
CHI-NYC	(7)*	5	3	(6)	(9)	(1)	(19)	(13)	3	(1)	(3)	(27)	4	4	(3)	7
NYC-CHI	(12)	2	7	4	(8)	(8)	(24)	(4)	(3)	(3)	(1)	(18)	20	8	(1)	15
CHI-SFO	39	27	6	27	(19)	(9)	(12)	(15)	(37)	(2)	1	(13)	6	(17)	2	(20)
SFO-CHI	18	14	10	21	12	(11)	(5)	(25)	(31)	19	8	(8)	8	(18)	1	(18)
LAX-NYC	15	5	5	9	(23)	(9)	(12)	4	20	(18)	(4)	(32)	(5)	5	(1)	17
NYC-LAX	18	7	(5)	17	(30)	(10)	(20)	(7)	11	11	11	(8)	(1)	(2)	0	(1)
NYC-SFO	27	(1)	7	3	(28)	(9)	(19)	(21)	20	17	8	6	(15)	(3)	(5)	(4)
SFO-NYC	8	10	1	29	0	(25)	(16)	(31)	8	15	15	(10)	(8)	(4)	1	(4)

*Numbers in parentheses indicate decrease

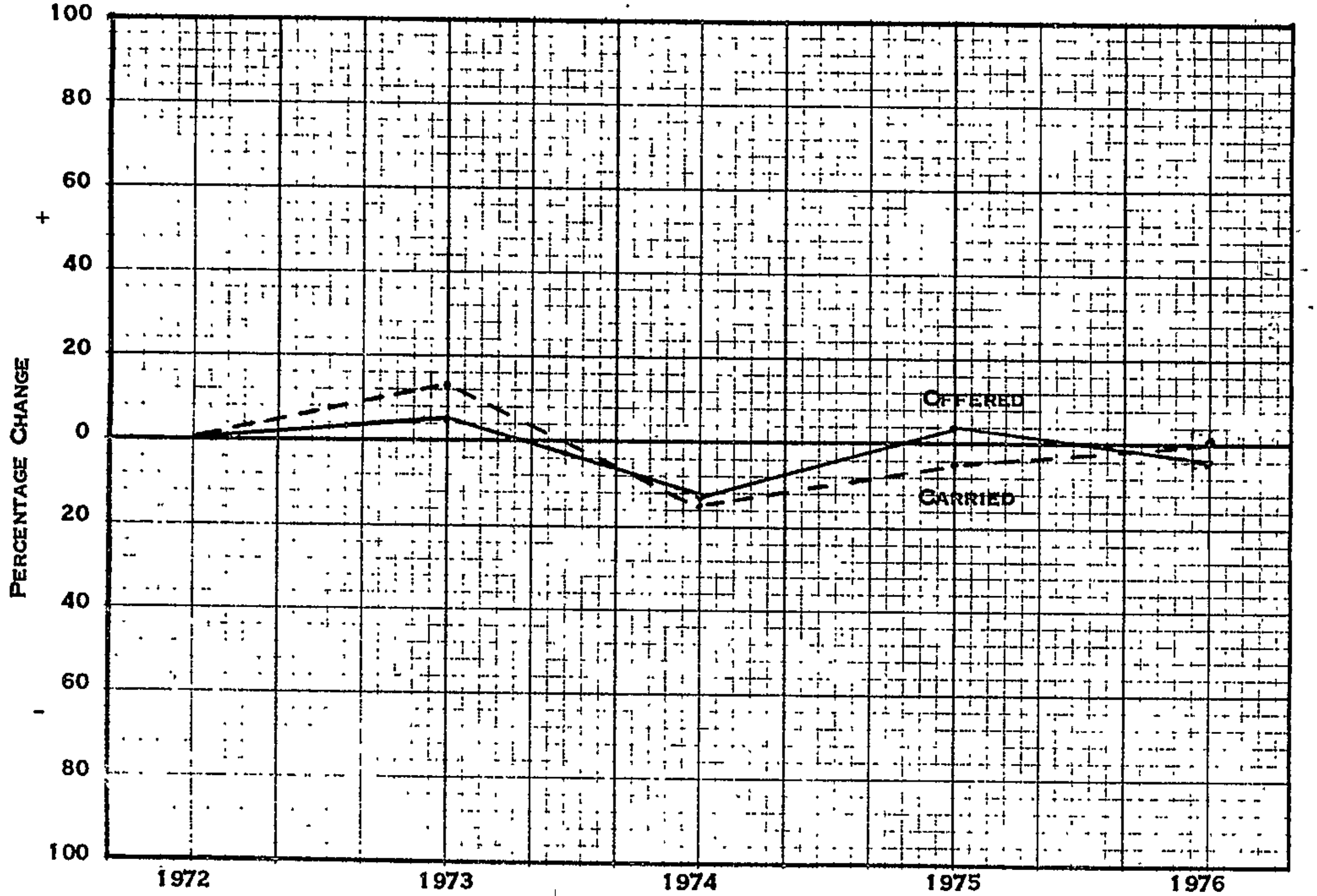

Figure 1-13. Total Air Cargo Services
Percent Change in Capacity Offered and Quantity Carried, 1972-1976
Combined Selected City-Pairs

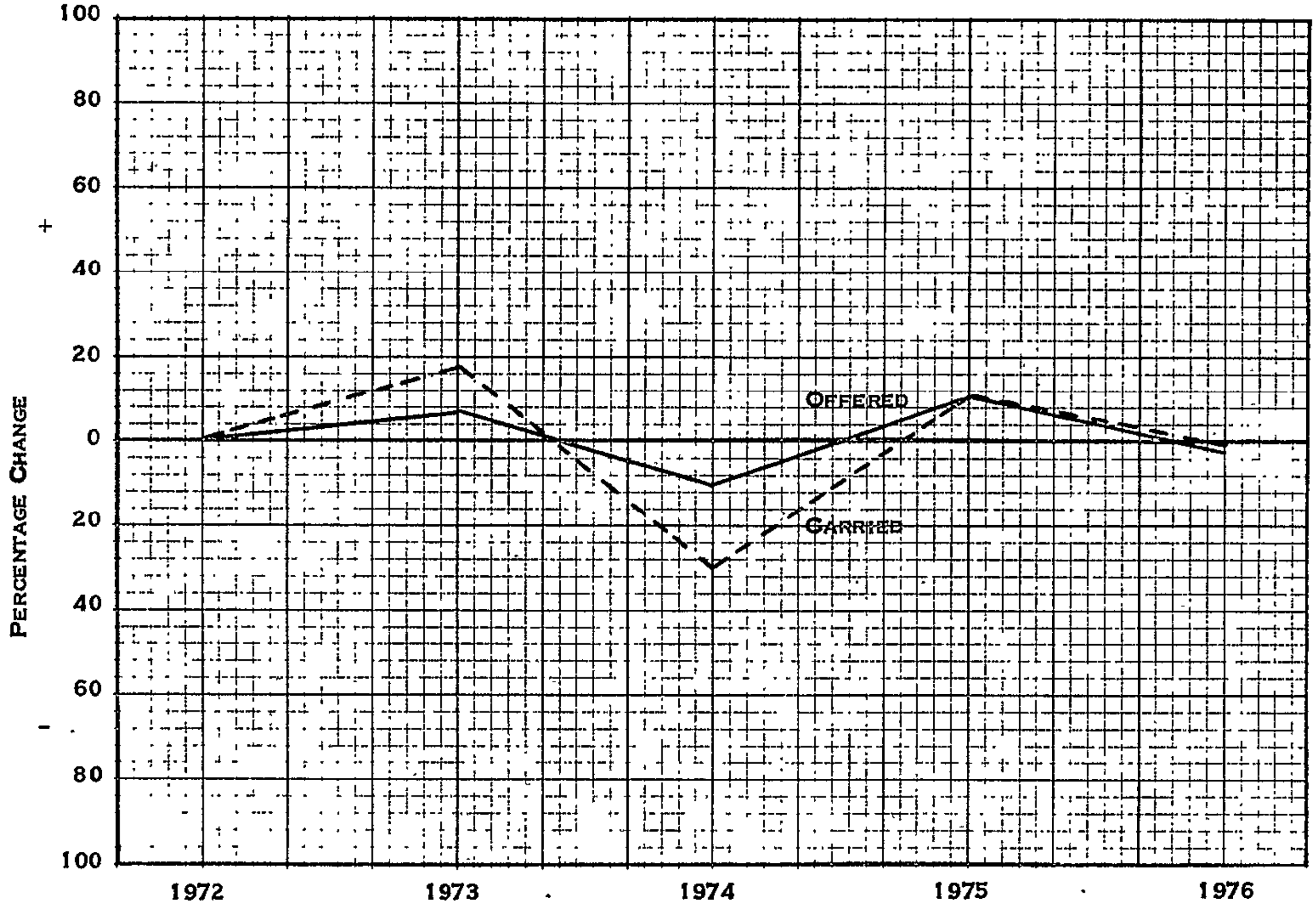

Figure 1-14. Total Air Cargo Services
Percent Change in Capacity Offered and Quantity Carried, 1972-1976
New York City-Los Angeles

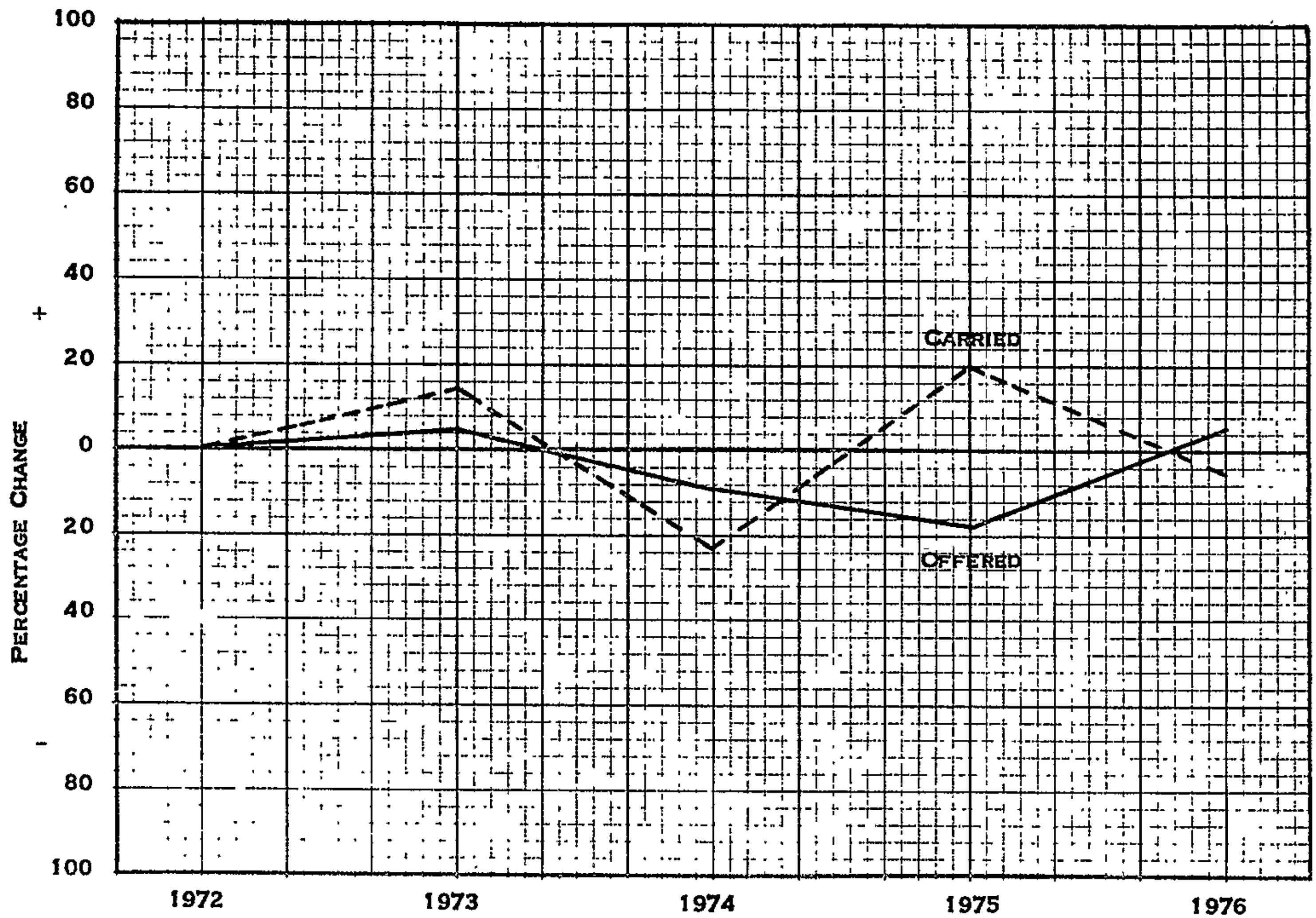

Figure 1-15. Total Air Cargo Services

Percent Change in Capacity Offered and Quantity Carried, 1972-1976

Los Angeles-New York City

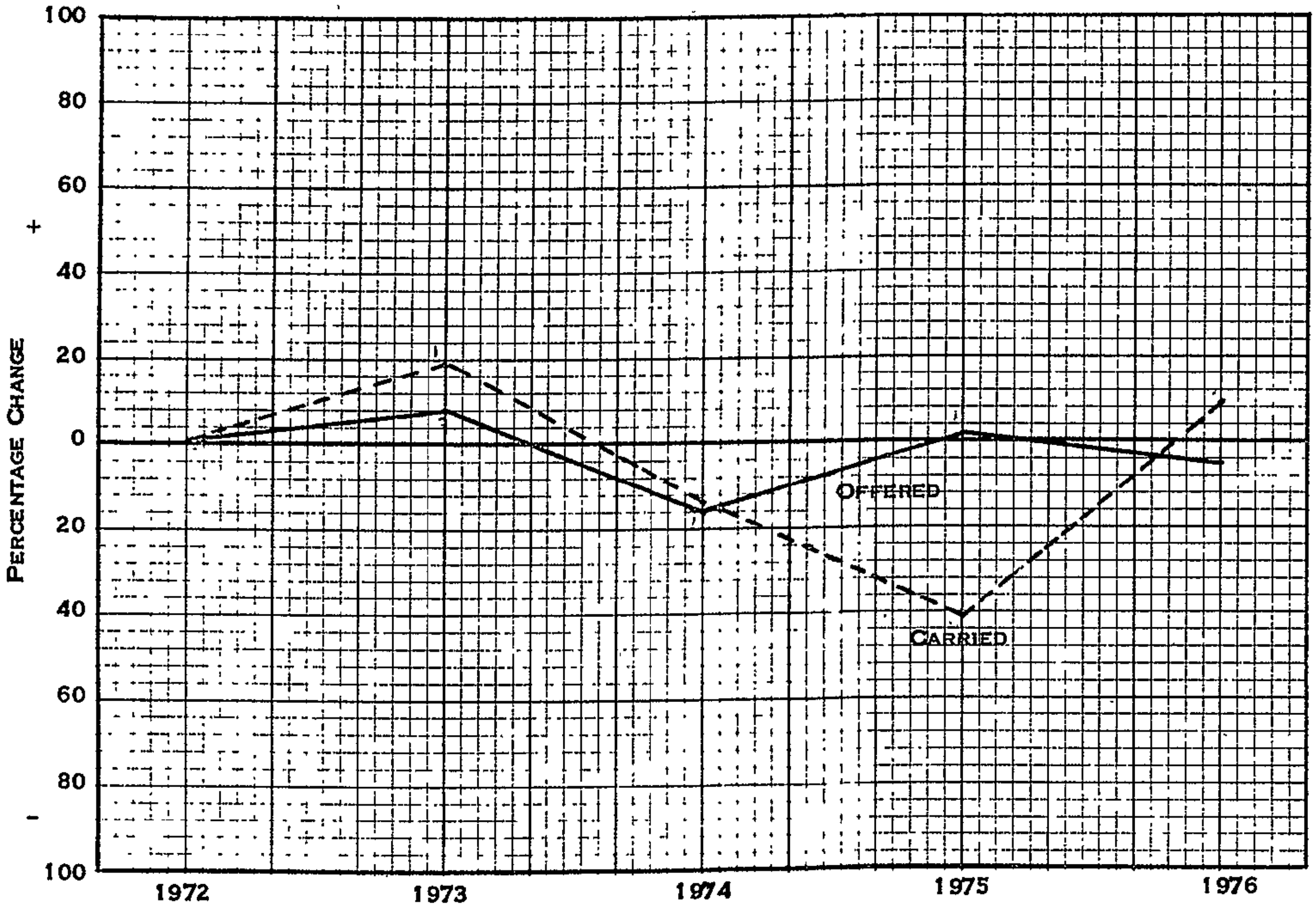

Figure 1-16. Total Air Cargo Services
Percent Change in Capacity Offered and Quantity Carried, 1972-1976
Chicago-Los Angeles

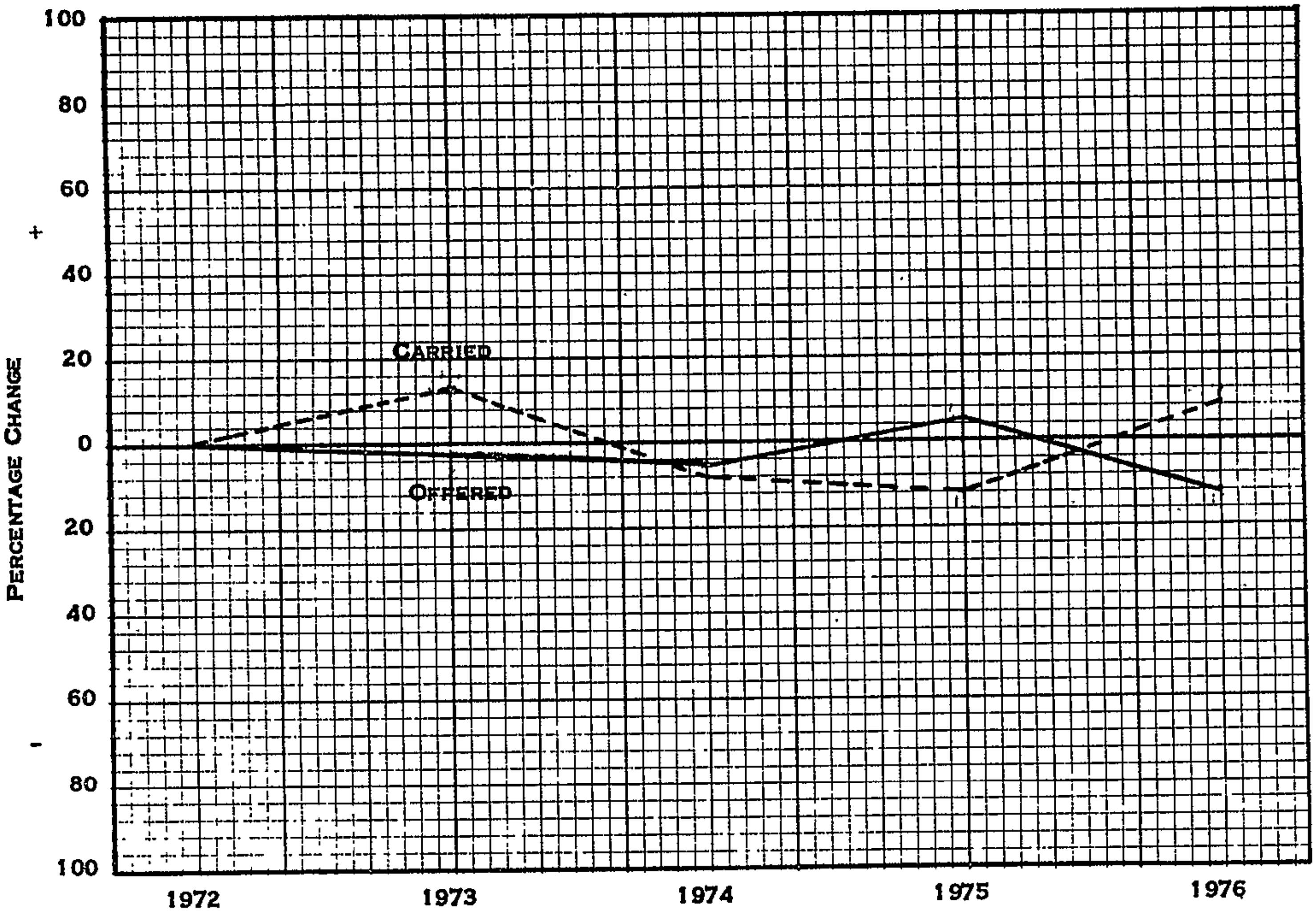

Figure 1-17. Total Air Cargo Services
Percent Change in Capacity Offered and Quantity Carried, 1972-1976
Los Angeles-Chicago

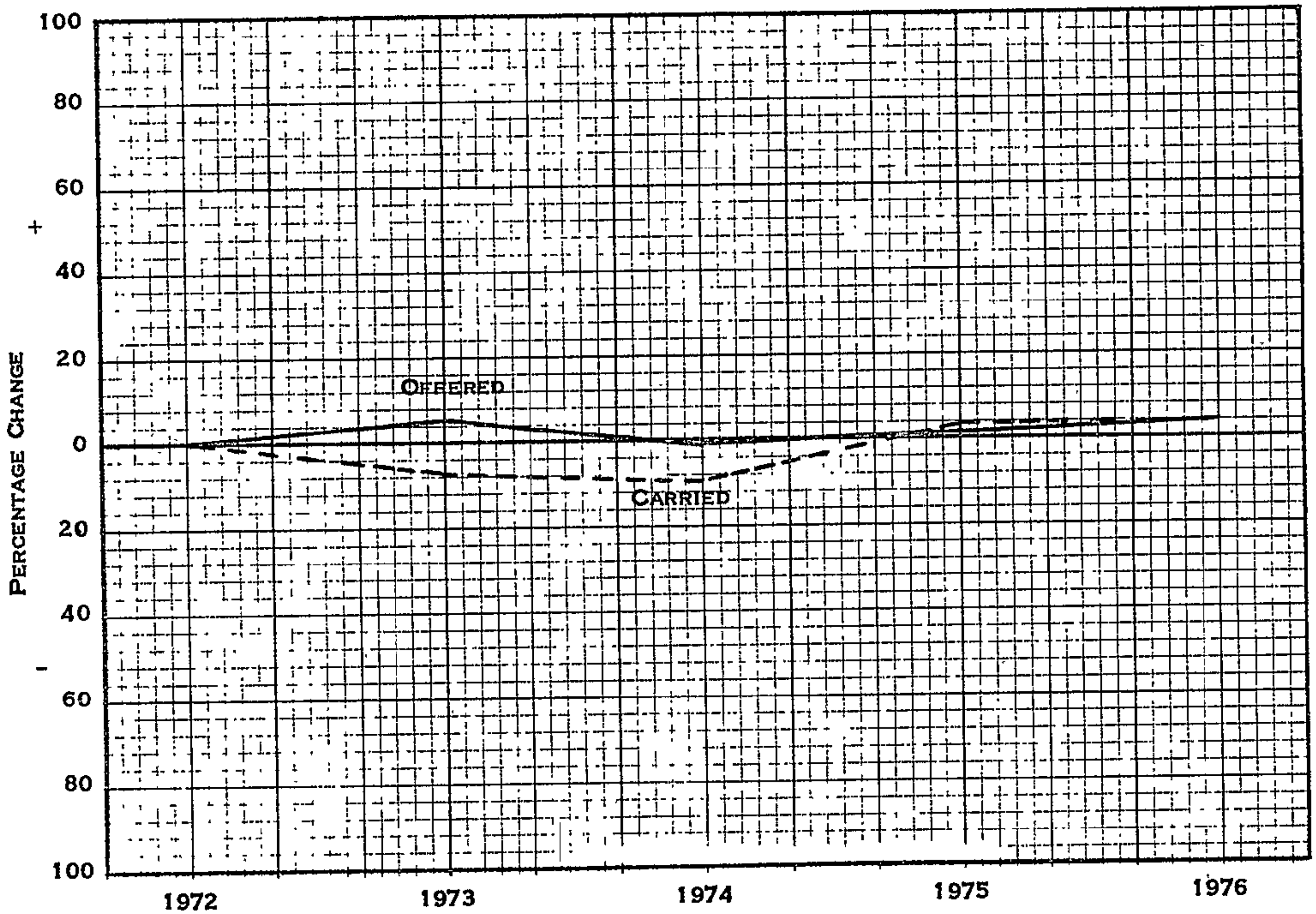

Figure 1-18. Total Air Cargo Service
Percent Change in Capacity Offered and Quantity Carried, 1972-1976
Chicago-New York City

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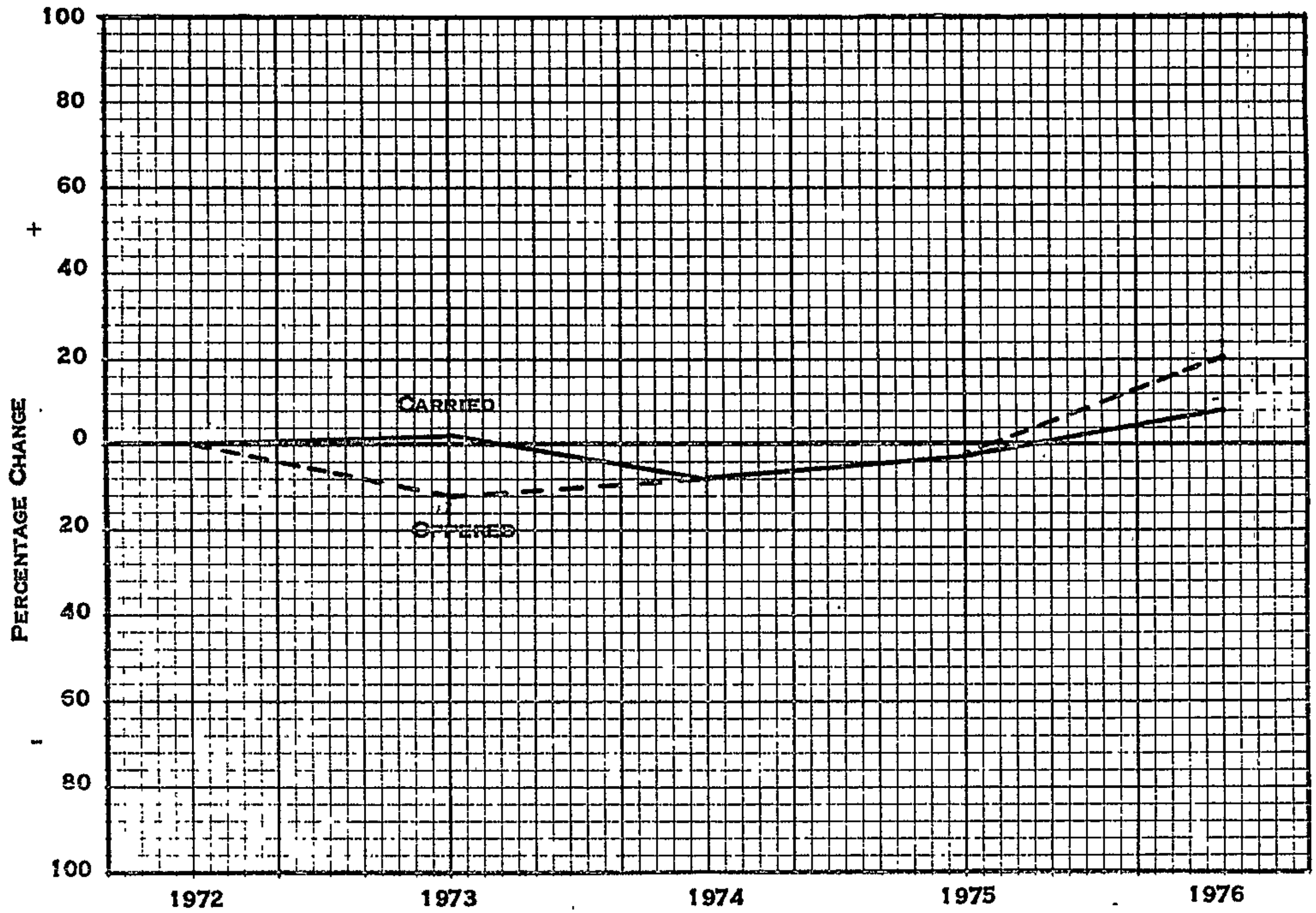

Figure 1-19. Total Air Cargo Services
Percent Change in Capacity Offered and Quantity Carried, 1972-1976
New York City-Chicago

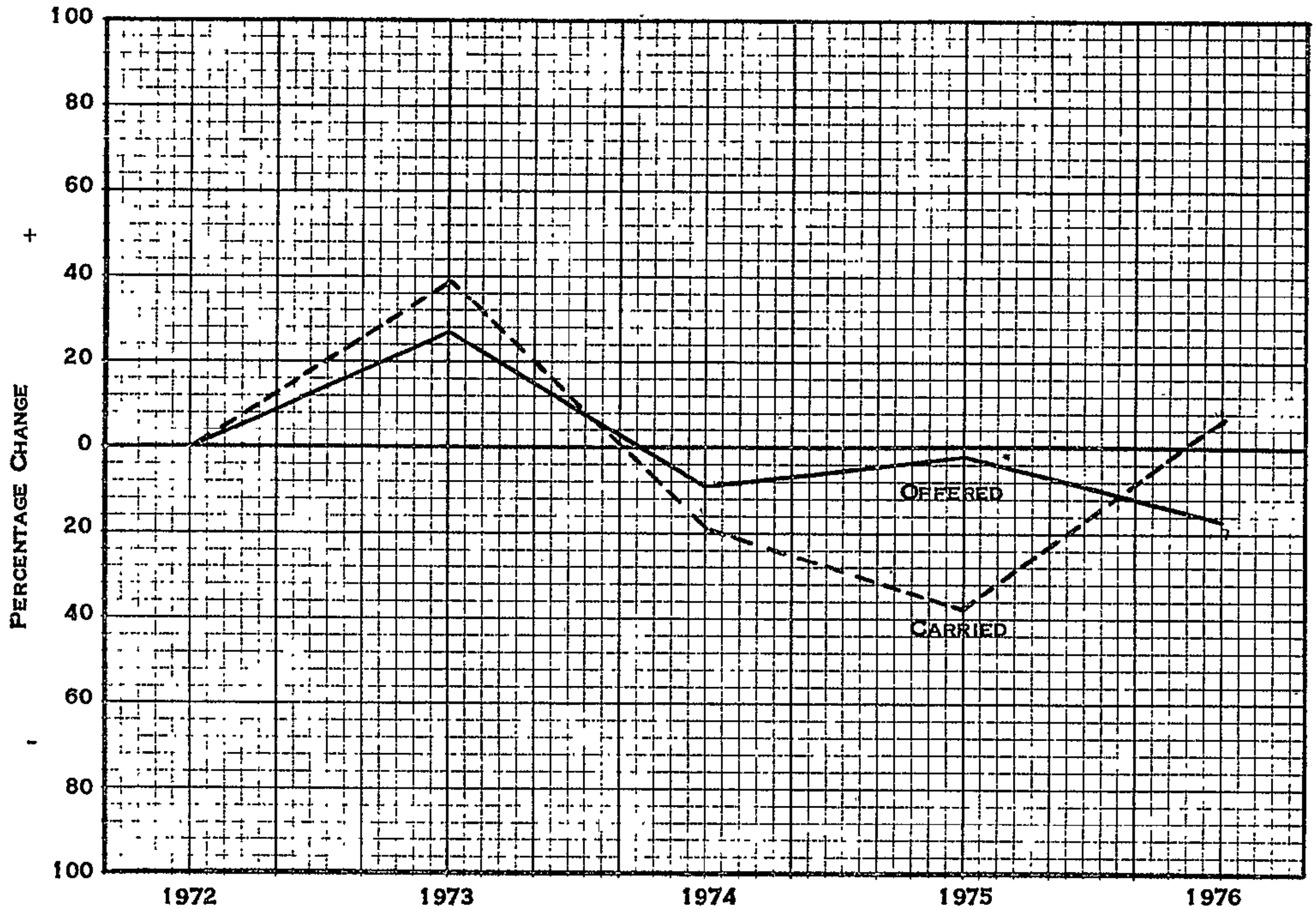

Figure 1-20. Total Air Cargo Services

Percent Change in Capacity Offered and Quantity Carried, 1972-1976

Chicago-San Francisco

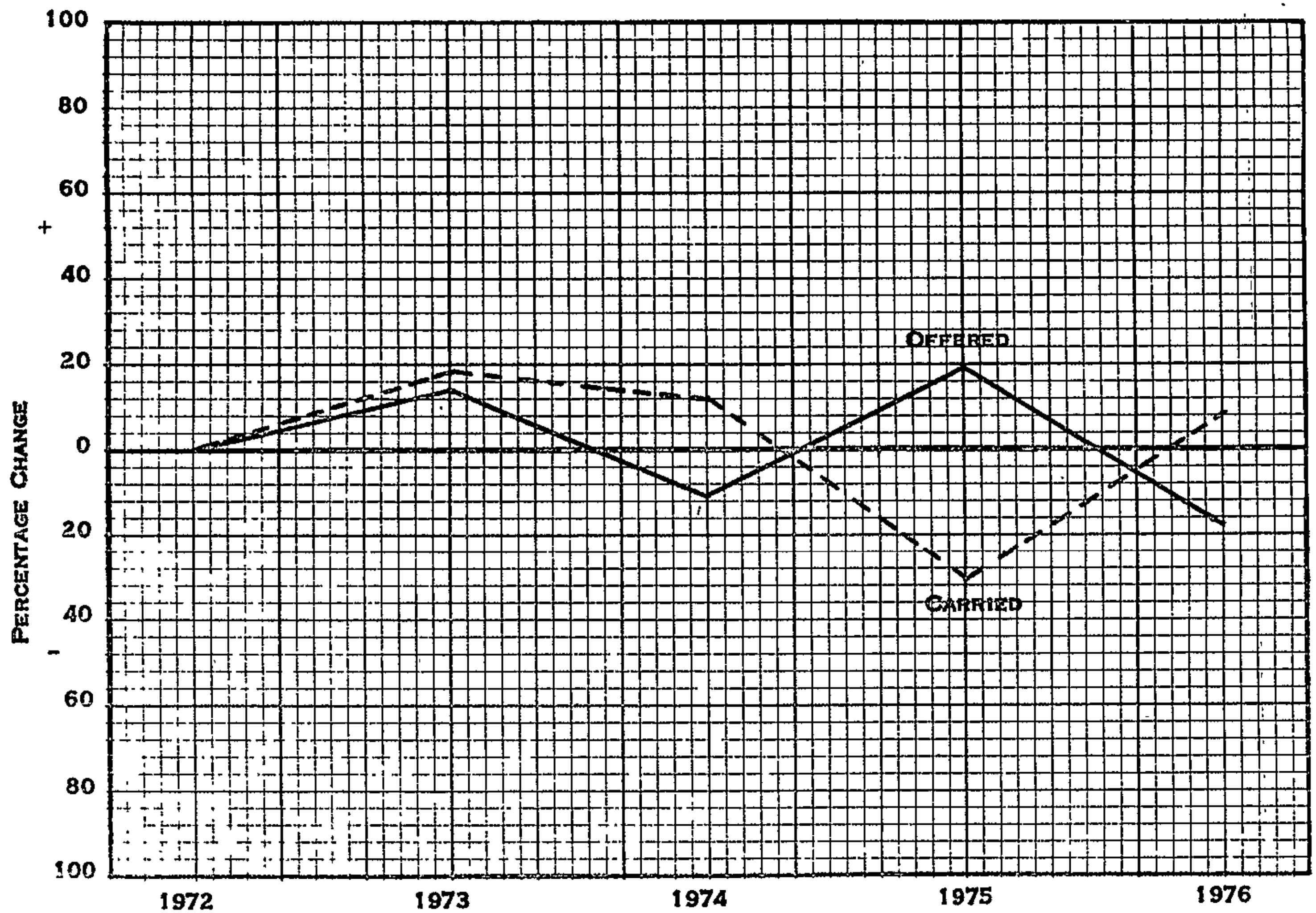

Figure 1-21. Total Air Cargo Services

Percent Change in Capacity Offered and Quantity Carried, 1972-1976

San Francisco-Chicago

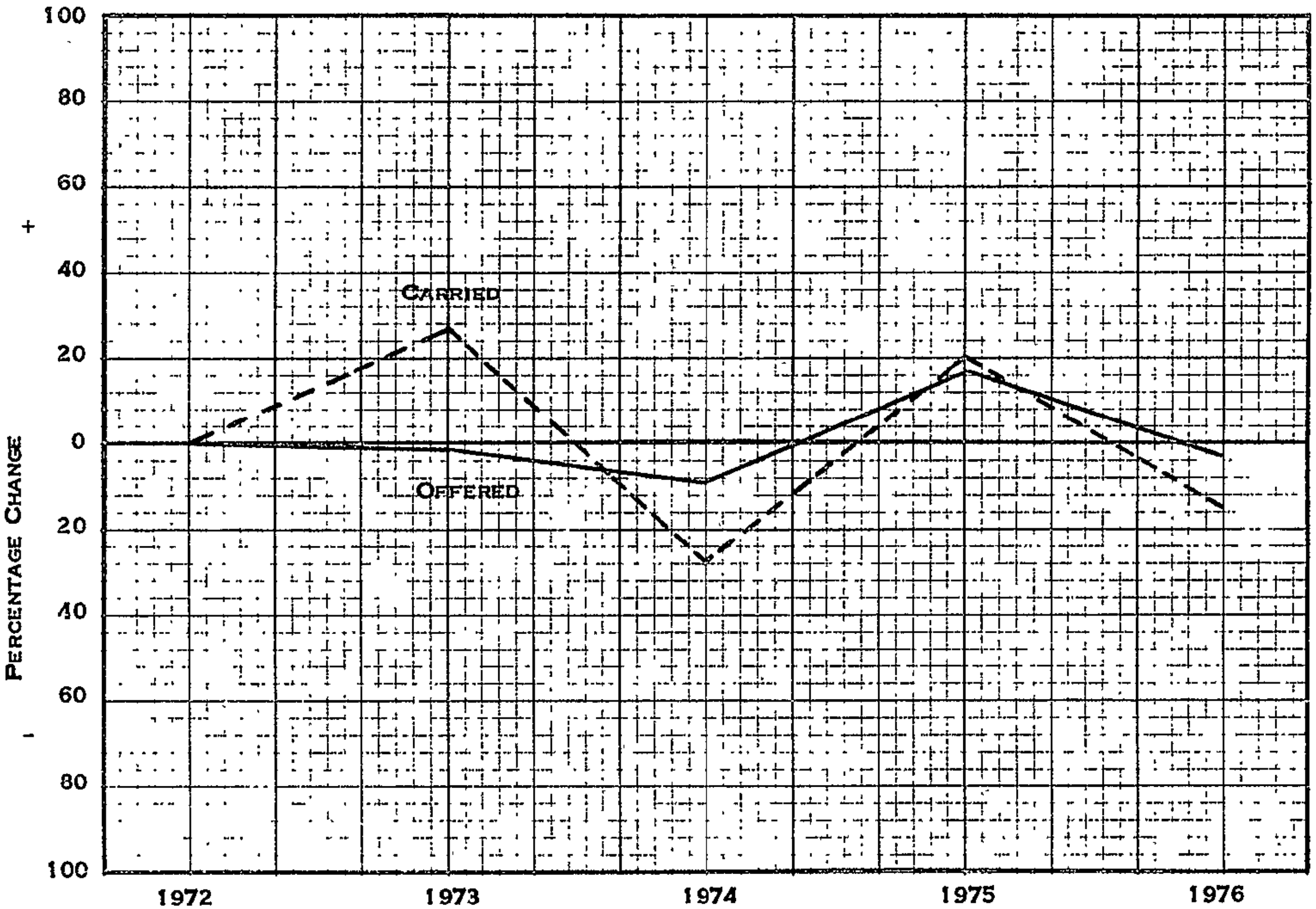

Figure 1-22. Total Air Cargo Services
Percent Change in Capacity Offered and Quantity Carried, 1972-1976
New York City-San Francisco

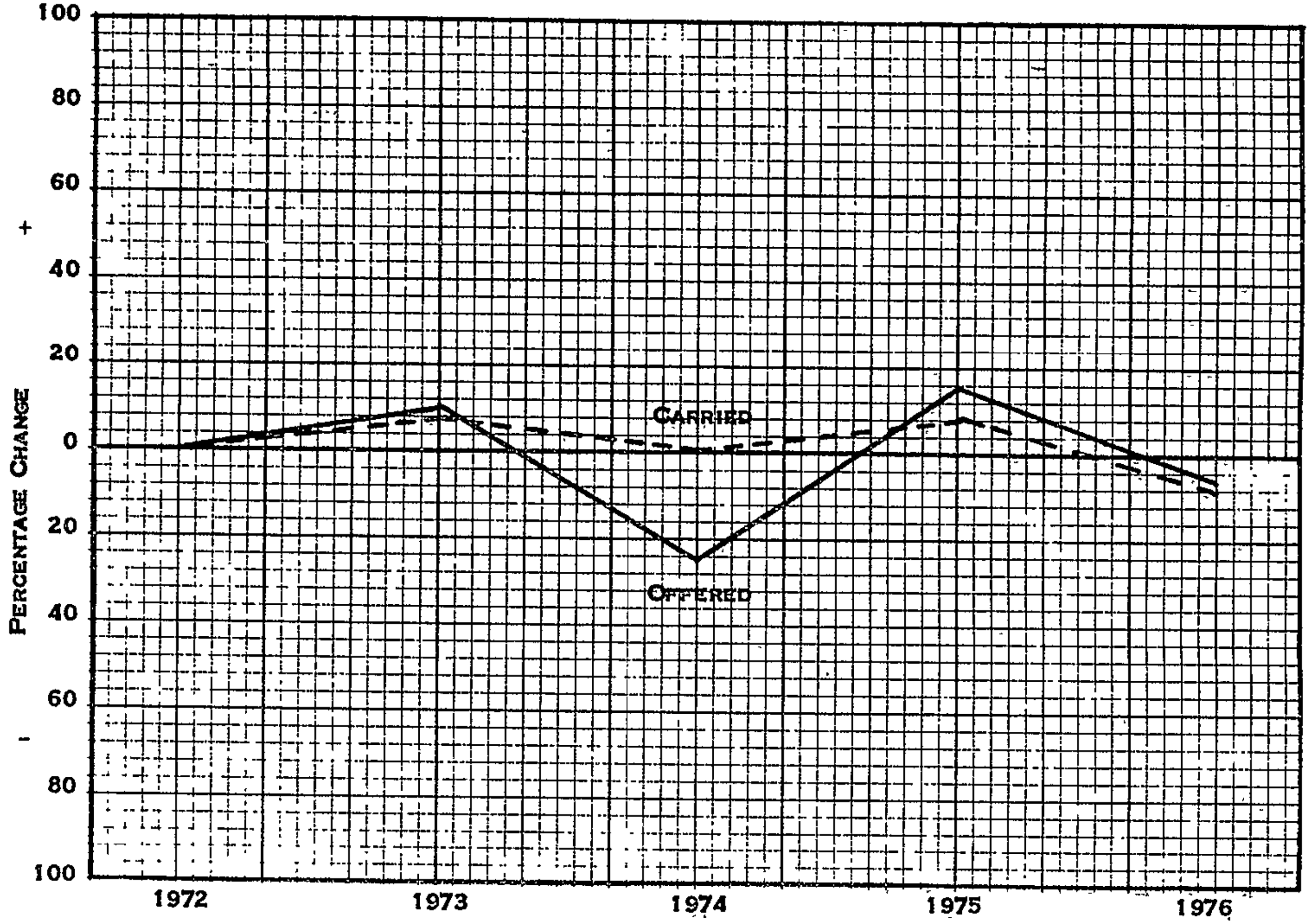

Figure 1-23. Total Air Cargo Services

Percent Change in Capacity Offered and Quantity Carried, 1972-1976

San Francisco-New York City

In regard to the transportation of small shipments, the air mode certainly does not have a monopoly. This characteristic is also true of a large segment of the trucking industry if special service vehicles are not considered. To gain additional perspective of small shipments (less than 4500 kilograms) transported by the airline industry, a brief analysis was made of the shipments tendered to an airline, to Federal Express, and the total number of intercity small shipments reported by the Bureau of Economics for 1974.

For reasons of disclosure, the airline is identified as a cooperative combination carrier whose data were provided for this analysis. Table 1-10 shows the carriers leading shipments by commodity description, shipments tendered/month, and the weight of these shipments. All of the shipments tendered directly to the airline from the shipper weighed less than 4500 kilograms. The number of shipments/month ranged from between one or two to as high as 219 (for automotive parts). Of interest is the quantity of shipments received by 11 of the originating stations throughout the airlines network. A high of 65 000 shipments/month were received and categorized (from the airlines shipper designation) as miscellaneous shipper, none of which exceeded 90 kilograms.

Table 1-11 shows Federal Express operating results for January 1977. Federal Express does not accept packages weighing in excess of 32 kilograms (approximately), and the significant element is that in one month the carrier handled 447 200 shipments representing 21 296 packages/day.

What appears to be a large quantity of shipments shown by these examples dwindles to insignificance when compared to the total number of intercity small shipments as categorized in Table 1-12 (Reference 1-7). In 1974, about 1760 million shipments were reported. The intercity transportation carriers, for all modes, handled over 4.8 million shipments per day. It can be summarized that in spite of deferred rates, priority services, etc., the airlines obtain only a small portion of this business.

Airfreight forwarders - Forwarders provide an important, possibly indispensable, service to the airfreight industry. United Parcel Service (UPS) is included in this analysis of airfreight forwarders despite the fact

TABLE 1-10

INFORMAL SURVEY OF AIRFREIGHT SHIPPERS
(DATA FROM COOPERATIVE COMBINATION CARRIER)

Commodity	Number Shippers	Shipments/Month			Shipment Size(Kg)/Month		
		Average	High	Low	Average	High	Low
Chemical Products and Supplies	12	7	25	1	323	1163	50
Plastic Products	4	10	17	1	381	770	170
Automotive Parts	10	55	219	1	164	322	82
Electronic Supplies and Equipment	8	6	16	1	259	738	6
Electrical Parts and Supplies	16	7	27	1	221	454	39
Newsprint, Periodicals	10	14	27	3	300	1337	24
Phonograph Records and Equipment	5	14	23	2	64	134	6
Textiles, Clothing	20	5	15	1	246	740	55
Food Products other than Fish	11	6	21	1	468	1489	23
Fish, Fish Products	15	8	44	1	386	828	133
Instruments for Measuring	13	3	12	1	132	388	18
Computer Parts and Supplies	5	28	98	1	251	641	35
Tractors, Earth-Moving Equipment	16	20	104	1	208	173	32
Miscellaneous	11 origin stations	16 770	65 000	4000	58	90	40

TABLE 1-11
FEDERAL EXPRESS OPERATING RESULTS
JANUARY 1977

Revenue (Millions of $)	$8.745
Shipments (Thousands of Packages)	447.2
Weight (Millions of Kilograms).	2.471
Weight/Shipment (Kilograms)	5.5
Packages/Day	21 296
Revenue/Shipment ($).	$119.55
Revenue/Pound ($)	$1.61

TABLE 1-12
TOTAL NUMBER OF INTERCITY SMALL SHIPMENTS

	Number of Shipments	Percent of Total	Type of Service
	784.8 Million	44.6	United Parcel Service
	431.2 Million	24.5	Parcel Post - Surface
	236.0 Million	13.4	Motor LTL Class I & II
	222.2 Million	12.6	Parcel Post - Air
	39.7 Million	2.2	Airfreight Forwarder
	20.5 Million	1.2	Bus Express
	11.9 Million	0.7	Class A Freight Forwarders
	8.9 Million	0.5	REA - Surface
	4.8 Million	0.3	REA - Air
Total	1760.0 Million	100.0	

that they are not officially classified as an airfreight forwarder and UPS does not consider airfreight forwarders to be competition. However, the Civil Aeronautics Board (CAB) through their Forms 244, Schedule T3-A, the primary source data of this analysis, lists UPS with airfreight forwarders.

UPS through their "Blue Label Air" service provides all of the activities of airfreight forwarders with restriction on the weight and size of the packages they receive from shippers and the type of commodities handled. These restrictions, specifically stated, are given below:

United Parcel Service

Commodities Handled and Weight and Size Restrictions

The carrier holds itself out to transport general commodities, as usually defined, subject to the following restrictions:

a. No service shall be rendered in the transportation of any package or article weighing more than 50 pounds or exceeding 108 inches in length and girth combined, and each package or article shall be considered as a separate and distinct shipment.

b. No service shall be provided in the transportation of packages or articles weighing in the aggregate more than 100 pounds from one consignor at one location to one consignee at one location at any one day.

c. The following kinds of merchandise are not handled: Baggage, Dangerous Articles, Flowers, Furs or Fur trimmed Garments, Hats, Jewelry (other than costume jewelry). Perishables, Personal Effects, Wearing Apparel on Hangers, Valuable Property, ANY SHIPMENT OF A DECLARED VALUE OF MORE THAN $1,000.

d. No service shall be rendered in the transportation of any Hazardous Materials which require a Department of Transportation Hazardous Materials Label, or as otherwise designated in the Official Air Transport Restricted Articles Tariff No. 6-D, CAB No. 82.

UPS has broad coverage of the Continental United States and Oahu, Hawaii. Customer's packages are sorted and assembled in 1200 package centers and 200 hub cities. No sorting takes place at airports as this function is performed at UPS hubs. Door-to-door delivery is provided to major cities in 2 days, i.e., pickup on Monday, delivery on Wednesday.

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All possible air shipments are containerized in a variety of containers including LDs and M2s. The company would prefer to use more of the large 8- x 8- x 20-foot M2 containers but there is insufficiency of aircraft capable of handling this container. For example, only 25 percent of UPS airfreight at LAX can be shipped in M2s.

Using the top 10 domestic United States city-pairs from the 1975 Douglas Domestic Shared Statistics (DDSS) as the basis for percentage distribution of airfreight handled by airfreight forwarders, UPS, and airlines direct, the role of airfreight forwarders and UPS is clearly defined. As stated elsewhere in this report, DDSS total represents 56 percent of the total airfreight market. The remainder being charter flights and a few nonreporting airlines.

As shown in Table 1-13 and Figures 1-24 and 1-25, airfreight forwarders and UPS account for 42.8 percent of the total airfreight transported between the top 10 city-pairs. This percentage of share of market varies between city-pairs with the highest percentage for airfreight forwarders and UPS having a high 73.1-percent share of the NYC-LAX market and a low 16.3-percent share of the SFO-NYC market.

Table 1-14 provides tonnage, percent of total, and UPS share of the airfreight forwarding market to 30 major domestic city-pairs arranged alphabetically. UPS has an average of 41.9 percent market share of the total 20 city-pairs. With only four exceptions (CHI-NYC, NYC-CHI, NYC-DFW, DFW-NYC), UPS has 32.0 to 66.4 percent of the market.

Analyses of the percent of total 30 city-pairs shows that major markets for both UPS and airfreight forwarders are the long- and medium-distance markets of NYC-LAX, LAX-NYC and CHI-LAX, LAX-CHI which represents over one-third of the total for both services.

In recent years, with the introduction of all-freighter aircraft capable of transporting up to 100 tonnes internationally, containerization, and the acceptance by some shippers of physical distribution management principles, the quantity of commodities transported by air has increased. As described previously, the quantity of air-transported commodities domestically was

TABLE 1-13

AIRFREIGHT FORWARDERS COMPARED TO AIRLINES

SHARE OF MARKET FOR TOP 10 DOMESTIC CITY-PAIRS, 1975

City Pair	Total	DDSS	United Parcel Service		All Other Freight Forwarders		Airlines Direct	
	Tonnes	Percent	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total
LAX-NYC	53 080	100.0	6 132	11.6	13 021	24.5	33 927	63.9
SFO-NYC	35 481	100.0	1 884	5.3	3 886	11.0	29 711	83.7
LAX-CHI	32 198	100.0	7 621	23.7	5 966	18.5	18 611	57.8
NYC-LAX	31 608	100.0	9 295	29.4	13 806	43.7	8 507	26.9
NYC-CHI	20 697	100.0	828	4.0	9 183	44.4	10 686	51.6
CHI-LAX	19 668	100.0	5 627	28.6	4 028	20.5	10 013	50.9
CHI-NYC	19 141	100.0	433	2.3	4 664	24.4	14 044	73.3
NYC-SFO	19 134	100.0	5 183	27.1	7 775	40.6	6 176	32.3
SFO-CHI	17 401	100.0	2 164	12.4	3 638	20.9	11 599	66.7
CHI-SFO	13 024	100.0	3 682	28.3	2 972	22.8	6 370	48.9
Total...	261 432	100.0	42 849	16.4	68 939	26.4	149 644	57.2

TABLE 1-14

AIRFREIGHT FORWARDERS QUANTITY OF AIRFREIGHT HANDLED

AND PERCENT SHARE UPS BY MAJOR U.S. DOMESTIC CITY-PAIRS, 1975

City-Pair	United Parcel Service		Airfreight Forwarders Other Than UPS		Total Airfreight Forwarders		UPS Percent of Total Airfreight Forwarders
	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	
ATL-LAX	1 720	2.3	2 408	2.3	4 128	2.3	41.7
BOX-LAX	2 781	3.7	2 873	2.7	5 654	3.1	49.2
BOS-SFO	1 687	2.2	1 661	1.7	3 348	1.9	50.4
CHI-LAX	5 627	7.5	4 028	3.8	9 655	5.4	58.6
CHI-NYC	433	0.6	4 663	4.5	5 096	2.8	8.5
CHI-SFO	3 682	4.9	2 972	2.8	6 654	3.7	55.3
CHI-SEA	1 824	2.4	1 195	1.1	3 019	1.7	60.4
DFW-NYC	63	0.1	1 990	1.9	2 053	1.1	3.1
DTW-LAX	804	1.1	1 672	1.6	2 476	1.4	32.5
DTW-SFO	425	0.6	1 057	1.0	1 482	0.8	28.7
LAX-ATL	3 429	4.5	2 264	2.2	5 693	3.2	60.2
LAX-BOS	2 858	3.8	2 779	2.7	5 637	3.1	50.7
LAX-CHI	7 621	10.1	5 966	5.7	13 587	7.6	56.1
LAX-DTW	1 766	2.3	1 783	1.7	3 549	2.0	49.8
LAX-NYC	6 132	8.1	13 022	12.5	19 154	10.8	32.0
LAX-PHL	3 886	5.1	2 202	2.1	6 088	3.4	63.8

TABLE 1-14.- Concluded

AIRFREIGHT FORWARDERS QUANTITY OF AIRFREIGHT HANDLED
AND PERCENT SHARE UPS BY MAJOR U.S. DOMESTIC CITY-PAIRS, 1975

City-Pair	United Parcel Service		Airfreight Forwarders Other Than UPS		Total Airfreight Forwarders		UPS Percent of Total Airfreight Forwarders
	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	
NYC-CHI	828	1.1	9 245	8.8	10 073	5.6	8.2
NYC-DFW	282	0.4	3 678	3.5	3 960	2.2	7.1
NYC-LAX	9 295	12.3	13 806	13.2	23 101	12.8	40.2
NYC-SFO	5 183	6.9	7 775	7.4	12 958	7.2	40.0
NYC-SEA	2 729	3.6	2 260	2.2	4 989	2.7	54.7
PHL-LAX	2 985	3.9	1 942	1.9	4 927	2.7	60.6
PHL-SFO	1 867	2.5	1 232	1.2	3 099	1.7	60.2
SFO-BOS	919	1.2	1 683	1.6	2 602	1.4	35.3
SFO-CHI	2 164	2.9	3 637	3.5	5 801	3.2	37.3
SFO-DTW	451	0.6	776	0.7	1 227	0.7	36.8
SFO-NYC	1 884	2.5	3 886	3.7	5 770	3.2	32.7
SFO-PHL	1 165	1.5	1 029	1.0	2 194	1.2	53.1
SEA-CHI	598	0.8	302	0.3	900	0.5	66.4
SEA-NYC	359	0.5	736	0.7	1 095	0.6	32.8
TOTALS	75 447	100.0	104 522	100.0	179 969	100.0	41.9

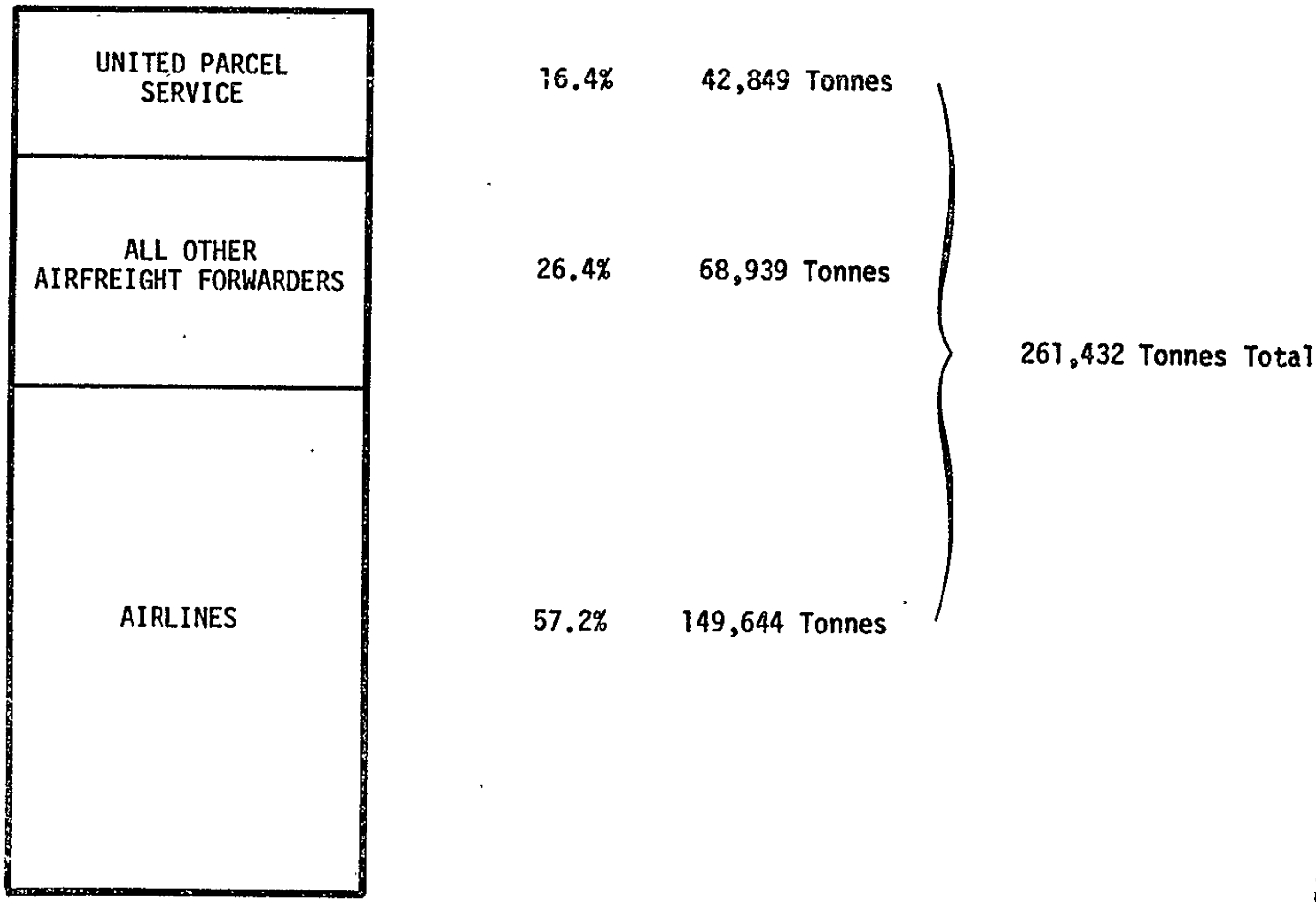

Figure 1-24. Airfreight Forwarders Compared to Airlines Share of Total Market for Total Top 10 City-Pairs, 1975

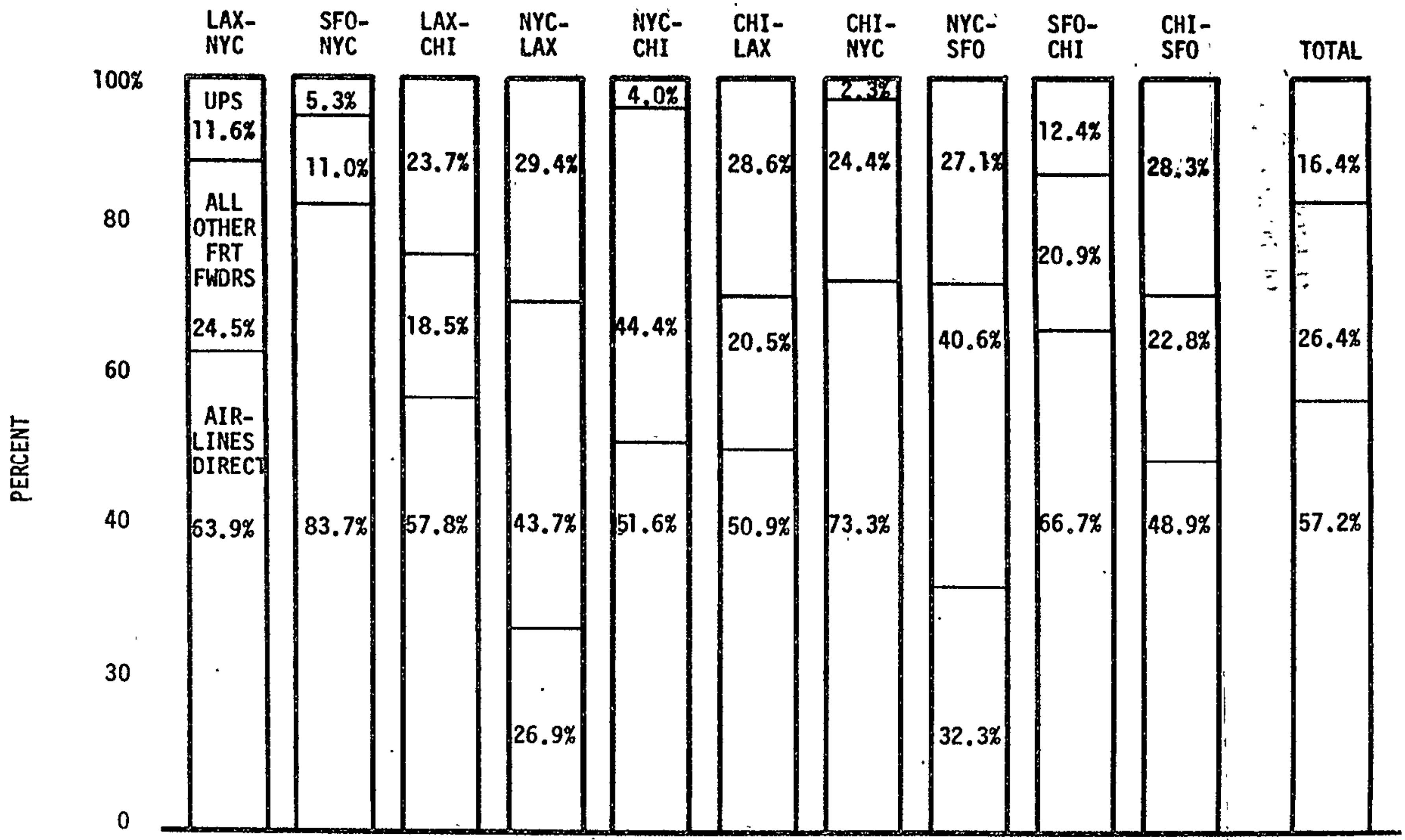

Figure 1-25. Airfreight Forwarders Compared to Airlines Share of Market for Top 10 City-Pairs, 1975

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616 million tonne-kilometers in 1960 increasing to 4216 million in 1976. However, the characteristics of the major commodities as transported have remained relatively constant. Data available from the Air Transport Association (Reference 1-6) show that, based on revenue tonne-kilometers, the following commodities rank among the top 10 for the years indicated.

Commodity	Rank by Year				
	1955	1965	1970	1971	1975
Machinery Parts and Equipment	1	1	3	3	1
Cut Flowers, Horticulture	2	7	6	5	3
Electrical Products	3	5	1	2	4
Wearing Apparel	4	3	2	1	5
Printed Matter	5	4	4	4	2
Auto Parts and Accessories	6	2	5	6	6
Aircraft Parts	7	-	10	-	8
General Hardware	8	9	-	-	-
Advertising Display Matter	9	-	-	-	-
Photographic Film	10	-	-	-	-
Metal Products	-	10	-	10	-
Phonograph Records, Tapes, Records	-	-	8	7	-
Fresh Produce	-	6	-	8	9

The United States Census of Transportation, 1972 (Reference 1-1), substantiates this ranking of air-transportable commodities.

Twenty four-digit SIC commodity classifications (Reference 1-8) accounted for 83 percent of all commodities transported by air in 1972. These 20 four-digit commodities and their percent of the total in 1972 are as follows. Five of the top 10 commodities appear in the listing. Actually, if produce, printed matter, and cut flowers had been included in the Census of Transportation, the comparison would very likely be 8 out of 10 of the top ranking commodities.

SIC (TCC)	SIC Description	Percent of Total
3714	Motor Vehicle Parts and Accessories	27
3461	Metal Stampings	7
3071	Miscellaneous Plastic Products	5
2819	Industrial Inorganic Chemicals	5
2831	Drugs, Biological, or Botanical	5
2331	Women's, Misses, or Children's Apparel	4
3561	Industrial Pumps	4
3452	Bolts, Nuts, Screws, Rivets	4
3573	Electronic Data Processing Equipment	4
2311	Men's, Youth's, or Boy's Clothing	3
2821	Plastic Materials	2
2911	Petroleum Refining Products	2
2844	Cosmetics or Perfumes	2
3357	Nonferrous Metal or Insulating Wire	2
3292	Asbestos Products	2
3643	Current Carrying Wire Devices	1
2841	Soap or other Detergents	1
2013	Meat Products	1
3061	Miscellaneous Fabricated Rubber Products	1
3499	Fabricated Metal Products, NEC	1

Analysis of selected markets: Tables 1-15 through 1-24 (Reference 1-1) present the major commodities transported by air in the top 10 air markets. Total tonnes of each commodity and the percent transported by air, truck, and rail are also provided. At the bottom of each table, total tonnes of all commodities transported on each origin-destination and the percent air are shown. Observations concerning each city-pair follow each table.

TABLE 1-15

PERCENTAGE DISTRIBUTION OF TRANSPORTATION MODE UTILIZED FOR SELECTED COMMODITIES AND MARKETS, 1972

Market	Commodity	Total Tonnes	Percent of Total		
			Air	Truck	Rail
LAX-NYC	Men's, Boy's Clothing	175.96	83.3	16.7	0.0
	Plastic Materials	63.64	14.5	85.5	0.0
	Cosmetics or Perfumes	822.52	29.2	70.8	0.0
	Paints, Enamel, Lacquer	7.66	16.5	83.5	0.0
	Miscellaneous Plastic Products	1311.44	2.0	32.3	65.6
	Aluminum, Aluminum Alloy	454.78	0.5	99.5	0.0
	Builders, Cabinet Hardware	48.72	1.2	98.8	0.0
	Bolts, Nuts, Screws, Rivets	1105.87	5.9	94.1	0.0
	Oil Field Machinery Equipment	45.79	44.5	55.5	0.0
	Industrial Pumps	844.04	9.1	90.9	0.0
	Electronic Data Processing	1616.58	86.3	13.7	0.0
	Manufacturing Products, NEC	165.49	17.6	82.4	0.0
	Total Tonnes 10 431.68				
	Air Tonnes 2 027.90				
	Percent, Air 19.4				

- LAX-NYC-major industries of the Los Angeles area are well-represented in this table. The apparel, plastic, cosmetic, electronic, and oil field machinery industries utilize the air mode to a significant degree. Especially impressive is the electronic data processing industry which transports 86.3 percent of its output to New York City by air. This significant share and shares for other commodities contribute to the fact that the LAX-NYC market with 19.4 percent share of total tonnes ranks higher than any of the other top 10 city-pairs.

TABLE 1-16

PERCENTAGE DISTRIBUTION OF TRANSPORTATION MODE UTILIZED FOR SELECTED COMMODITIES AND MARKETS, 1972

Market	Commodity	Total Tonnes	Percent of Total		
			Air	Truck	Rail
NYC-LAX	Women's, Children's Clothing	1689.36	47.0	52.3	0.6
	Containers, Boxes	256.24	14.2	42.6	43.3
	Drugs	1712.18	1.1	48.0	50.0
	Cosmetics	1618.65	0.4	47.2	52.4
	Miscellaneous Plastic Products	4814.07	0.5	44.0	55.6
	Luggage, Leather or Other	2045.77	2.4	75.0	22.6
	Nonferrous Metal or Insulate	3829.94	14.7	3.9	81.5
	Miscellaneous Aircraft Parts Equipment	25.60	52.8	47.2	0.0
	Total Tonnes 21 185.95				
	Air Tonnes 1 504.12				
	Percent Air 7.1				

- NYC-LAX - again reflecting historical production capabilities and serving destination market needs, airfreight from NYC to LAX is greatest among the commodities "women's, children's clothing" and "miscellaneous aircraft parts and equipment". Transportation of these two commodities was shared in nearly equal proportions by air and truck. Although total tonnes in this direction of the origin-destination are approximately double that of LAX-NYC, the opposite is true of the air mode with LAX-NYC having 19 percent of total and NYC-LAX having 7 percent.

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TABLE 1-17

PERCENTAGE DISTRIBUTION OF TRANSPORTATION MODE UTILIZED FOR SELECTED COMMODITIES AND MARKETS, 1972

Market	Commodity	Total Tonnes	Percent of Total		
			Air	Truck	Rail
SFO-NYC	Electrical Measuring Instruments	119	88.3	10.9	0.8
	Total Tonnes 19 387				
	Air Tonnes 150				
	Percent, Air 0.8				

- SFO-NYC - One commodity has an outstanding share in this market, i.e., "electrical measuring instruments" 88 percent of which is transported by air to NYC. Undoubtedly, if produce had been included in the census it would appear in this listing.

TABLE 1-18

PERCENTAGE DISTRIBUTION OF TRANSPORTATION MODE UTILIZED FOR SELECTED COMMODITIES AND MARKETS, 1972

Market	Commodity	Total Tonnes	Percent of Total		
			Air	Truck	Rail
NYC-SFO	Women's, Children's Clothing	2495.68	27.1	72.1	0.8
	Drugs	2879.44	0.5	86.3	13.2
	Miscellaneous Plastic Products	1202.45	5.4	94.6	0.0
	Luggage, Leather and Other	773.01	0.2	87.7	12.1
	Metal Stampings	2705.78	4.6	28.9	66.5
	Miscellaneous Aircraft Parts	2.01	100.0	0.0	0.0
	Total Tonnes 13 257.39				
	Air Tonnes 883.84				
	Percent, Air 6.7				

- NYC-SFO - the commodity "women's, children's clothing" is the primary commodity air-transported between this origin-destination with air accounting for 27 percent of the total 2496 tonnes. It is interesting to note that only 0.5 percent of the commodity "drugs" is transported by air. This commodity represents 22 percent of all commodities transported on this city-pair and possesses characteristics which cause a product to be air-eligible.

TABLE 1-19

PERCENTAGE DISTRIBUTION OF TRANSPORTATION MODE UTILIZED FOR SELECTED COMMODITIES AND MARKETS, 1972

Market	Commodity	Total Tonnes	Percent of Total		
			Air	Truck	Rail
LAX-CHI	Men's, Boy's Clothing	648.90	35.0	65.0	0.0
	Cosmetics, Perfumes	1283.89	5.4	94.6	0.0
	Bolts, Nuts, Screw, Rivets	844.14	2.4	97.6	0.0
	Metal Stampings	463.59	0.7	99.3	0.0
	Oilfield Machinery Equipment	26.58	27.2	72.8	0.0
	Industrial Pumps	469.32	16.6	83.4	0.0
	Electronic Data Processing	164.72	71.8	28.2	0.0
	Manufacturing Products, NEC	244.63	5.9	94.1	0.0
	Total Tonnes 55 247.77 Air Tonnes 585.55 Percent, Air 1.1				

- LAX-CHI - Again, in this market, air is the preferred mode for shipping "electronic data processing" equipment (72 percent of the total). "Oilfield machinery equipment, industrial pumps, and men's, boy's clothing" also have respectable shares of the transportation of commodities to CHI.

TABLE 1-20

PERCENTAGE DISTRIBUTION OF TRANSPORTATION MODE UTILIZED FOR SELECTED COMMODITIES AND MARKETS, 1972

Market	Commodity	Total Tonnes	Percent of Total		
			Air	Truck	Rail
CHI-LAX	Fabricated Rubber Products	292	6.9	86.7	6.4
	Plastic Products	3898	4.3	95.7	0.0
	Nonferrous Metal	677	13.0	87.0	0.0
	Bolts, Nuts, Screws, Rivets	4841	1.2	98.8	0.0
	Current Carrying Wire Devices	415	4.4	90.8	4.7
	Total Tonnes 384 516				
	Air Tonnes 368				
	Percent, Air 0.1				

- CHI-LAX - Although the total of all commodities transported on this origin-destination is the largest of the 10 city-pairs considered, only 0.1 percent or 368 tonnes were air transported. Truck is predominant in this medium-distance market transporting 87 to 99 percent of five commodities which had some air penetration.

TABLE 1-21

PERCENTAGE DISTRIBUTION OF TRANSPORTATION MODE UTILIZED FOR SELECTED COMMODITIES AND MARKETS, 1972

Market	Commodity	Total Tonnes	Percent of Total		
			Air	Truck	Rail
SFO-CHI	Metal Cans	5.00	10.7	89.3	0.0
	Fabricated Metal Products NEC	1.10	100.0	0.0	0.0
	Electronic Measuring Instrument	9.79	11.7	88.3	0.0
	Miscellaneous Electronic Components	7.00	43.8	56.2	0.0
	Total Tonnes 17 670.46				
	Air Tonnes 33.06				
	Percent, Air 0.2				

- SFO-CHI - Total tonnes transported on this origin-destination is the smallest of the 10 city-pairs. The commodity "miscellaneous electronic components" has a significant share (44 percent) of the total transported; however, the quantity is small - 7 tonnes.

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TABLE 1-22

PERCENTAGE DISTRIBUTION OF TRANSPORTATION MODE UTILIZED FOR SELECTED COMMODITIES AND MARKETS, 1972

Market	Commodity	Total Tonnes	Percent of Total		
			Air	Truck	Rail
CHI-SFO	Miscellaneous Fabricated Rubber Products	21.54	17.9	0.0	82.1
	Miscellaneous Plastic Products	2 068.86	1.1	81.9	17.0
	Nonferrous Metal Base	632.73	1.1	98.9	0.0
	Bolts, Nuts, Screws, Rivets	181.41	9.7	90.3	0.0
	Miscellaneous General Industrial	2.51	100.0	0.0	0.0
	Miscellaneous Electrical Industrial	121.18	17.6	82.4	0.0
	Lighting Fixtures	793.53	1.5	98.5	0.0
	Current-Carrying Wire Devices	34.87	2.1	71.4	26.5
	Motor Vehicle Parts, Accessories	23 334.89	1.2	4.7	94.1
	Total Tonnes 171 086.60				
	Air Tonnes 367.71				
	Percent, Air 0.2				

- CHI-SFO - This medium-haul market differs from other major air markets in that rail predominates in two commodities. This mode is used to transport 82 percent of "miscellaneous fabricated rubber products" and 94 percent of "motor vehicle parts and accessories". Air is used for 18 percent of "miscellaneous electrical industrial" commodities and 10 percent of "bolts, nuts, screws, and rivets". Although this market is the second largest of the 10, only 0.2 percent of the total commodities were transported by air.

1-2-3

TABLE 1-23

PERCENTAGE DISTRIBUTION OF TRANSPORTATION MODE UTILIZED FOR SELECTED COMMODITIES AND MARKETS, 1972

Market	Commodity	Total Tonnes	Percent of Total		
			Air	Truck	Rail
NYC-CHI	Women's, Children's Clothing	3019.35	19.9	77.3	2.8
	Paper Boxes, Containers	2680.67	6.8	56.2	37.0
	Drugs	8029.45	0.1	99.9	0.0
	Cosmetics, Perfume	2319.43	0.6	39.8	59.7
	Luggage, Leather or Other	1753.58	0.1	86.4	13.6
	Total Tonnes 43 527.67				
	Total Air Tonnes 809.13				
	Percent, Air 1.9				

- NYC-CHI - In this market, only one commodity "women's, children's clothing" is shipped to a significant extent by air. Trucks have practically 100 percent of the commodity "drugs". Somewhat surprisingly, rail is used for 60 percent of the "cosmetic, perfume traffic."

TABLE 1-24

PERCENTAGE DISTRIBUTION OF TRANSPORTATION MODE UTILIZED FOR SELECTED COMMODITIES AND MARKETS, 1972

Market	Commodity	Total Tonnes	Percent of Total		
			Air	Truck	Rail
CHI-NYC	Petroleum Products	30.54	35.9	64.1	0.0
	Miscellaneous Fabricated Rubber	429.93	0.9	15.1	84.0
	Miscellaneous Plastic Products	1819.58	5.6	71.1	23.4
	Asbestos Products	6211.91	0.1	99.9	0.0
	Nonferrous Metal	98.44	41.4	58.6	0.0
	Primary Metal, NEC	39.75	16.8	83.2	0.0
	Bolts, Nuts, Screws, Rivets	688.44	60.9	39.1	0.0
	Machine Tools, Metal Forming	122.25	0.2	99.8	0.0
	Miscellaneous General Production Machinery	278.93	3.5	96.5	0.0
	Miscellaneous Office Machines	1549.26	1.3	98.7	0.0
	Miscellaneous Electrical Ind.	1.21	100.0	0.0	0.0
	Current-Carrying Wire Devices	208.36	3.0	97.0	0.0
	Photographic Equipment	1676.23	28.0	72.0	0.0
	Total Tonnes 158 797.86 Air Tonnes 1 104.03 Percent, Air 0.7				

- CHI-NYC - Air is used to a considerable degree in this market for the following commodities: "bolts, nuts, screws, and rivets, photographic equipment, petroleum products, and nonferrous metal products." Rail rather than truck predominates in the transportation of "miscellaneous fabricated rubber products."

Air transportation of printed products: Printed products as defined by the United States Bureau of the Census (Reference 1-9) include the following:

SIC Code	Classification
2731	Book publishing
2732	Book printing
2741	Miscellaneous publishing
2751	Commercial printing, except lithographic
2752	Commercial printing, lithographic
2753	Engraving and plate printing
2761	Manifold business forms
2771	Greeting card publishing
2782	Blankbooks and looseleaf binders
2789	Bookbinding and related work
2791	Typesetting
2793	Photoengraving
2794	Electrotyping and sterotyping

In conjunction with the 1972 Census of Transportation, the Bureau of the Census conducted a separate mail survey of 1000 printing and publishing organizations to determine transportation mode, origin/destination, and value of these commodities. Although useful, this information does not include tonnage,which is of paramount importance to this study. From a different source, Civilian Aeronautics Board Docket 22859 (Reference 1-10), a base figure for 1968 was obtained for three of the classifications and projected to 1972 as shown in Table 1-25. These three classifications, books, greeting cards, and periodicals account for 70 049 tonnes when projected to 1972. The printing industry is forecasted to grow at the rate of approximately 8 percent a year. If this growth factor is applied to the three commodities for which we have tonnage, the current figure (1977) would be 103 000 tonnes.

TABLE 1-25

PROJECTED TONNAGE OF SELECTED PRINTED MATTER SHIPPED BY AIR, 1968 - 1972

Commodity	1968		1969		1970		1971		1972	
	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total
Books[(a)]	907	1.4	952	1.5	1 000	1.5	1 050	1.5	1 103	1.6
Greeting Cards	3 701	5.8	4 016	6.2	4 357	6.5	4 727	6.9	5 129	7.3
Periodicals	58 957	92.8	60 136	92.3	61 339	92.0	62 566	91.6	63 817	91.1
	63 565	100.0	65 104	100.0	66 696	100.0	68 343	100.0	70 049	100.0

(a) Includes textbooks, trade books, subscription reference books, and miscellaneous books

C-2

From the standpoint of evaluation, as shown in Table 1-26 (Reference 1-10), these three classifications account for 15 percent and if we add the classification "products of service industries for the printing trades" to our three previous classifications, the four account for 33 percent of total evaluation of air transported printing commodities.

Table 1-26 provides the value and percent of total transported by each of the three modes, rail, motor carrier, and air. The total, by selected transportation mode, is shown in the following chart. Other modes of transportation as reported in the Special Report Series of the 1972 Census of Transportation (Reference 1-11) have been excluded as they are used primarily for intracity transport which is not within the scope of this study.

PERCENT DISTRIBUTION OF PRINTED PRODUCTS BY SELECTED TRANSPORTATION MODE, 1972

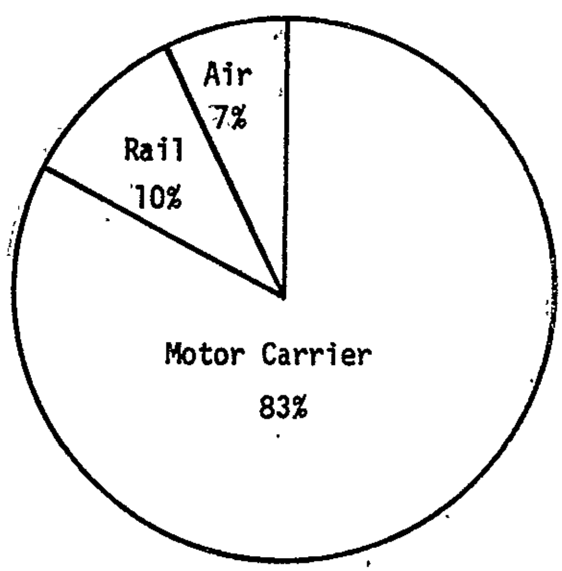

TABLE 1-26

PERCENT DISTRIBUTION OF PRINTED COMMODITIES SHIPPED BY SELECTED MODES OF TRANSPORTATION, 1972

SIC Code	Commodity	Total		Rail		Motor Carrier		Air	
		Value ($1000)	Percent	Value ($1000)	Percent of Total	Value ($1000)	Percent of Total	Value ($1000)	Percent of Total
27111	Newspapers	55 747	100.0			55 479	99.5	268	0.5
27211	Periodicals	552 821	100.0	167 926	30.4	366 482	66.3	18 413	3.3
27311	Books	1 329 212	100.0	119 544	8.9	1 161 281	87.5	48 387	3.6
27411	Catalogues and Directories	770 756	100.0	130 520	16.9	578 411	75.0	61 825	8.1
27417	Labels, Tags, Seals and Wrappers	466 146	100.0	33 142	7.1	414 272	88.9	18 732	4.0
27419	Printed Material (NEC)	2 658 875	100.0	187 757	7.1	2 186 455	82.2	284 663	10.7
27611	Manifold Business Forms	1 226 990	100.0	87 515	7.1	1 114 471	90.8	25 004	2.1
27711	Greeting Cards	547 013	100.0	42 150	7.7	483 320	88.4	21 543	3.9
27811	Blankbooks, Pads and Tablets	106 587	100.00	12 066	11.3	92 510	86.8	2 011	1.9
27812	Looseleaf Binders and Devices	70 424	100.0	598	0.8	67 311	95.6	2 515	3.6
27911	Products of Service Industries for the Printing Trade	414 103	100.0	11 865	2.9	290 703	70.2	111 535	26.9
	All Others	101 324	100.0	35 243	34.8	61 764	60.9	4 317	4.3
	TOTAL	8 299 998	100.0	828 326	10.0	6 872 459	82.8	599 213	7.2

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TABLE 1-27

PERCENT DISTRIBUTION OF PRINTED PRODUCT SHIPMENTS FROM GEOGRAPHIC REGIONS (BASED ON VALUE OF SHIPMENTS)

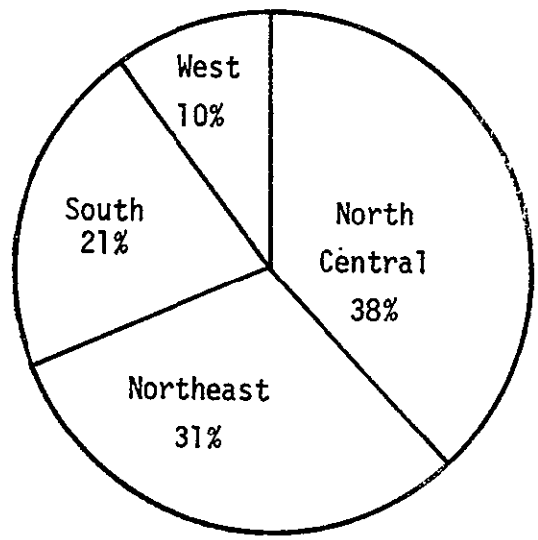
Division of Destination	Region of Origin				
	U.S.	Northeast	N. Central	South	West
Percent Distribution					
Total	100.0	100.0	100.0	100.0	100.0
New England	7.2	14.8	3.8	4.7	1.1
Middle Atlantic	24.8	45.5	15.9	20.1	3.2
East North Central	18.7	9.8	35.4	9.0	2.9
West North Central	8.3	4.4	15.1	4.7	1.7
South Atlantic	11.4	8.0	7.8	27.3	2.5
East South Central	4.9	3.7	4.3	9.7	1.3
West South Central	6.9	3.7	5.8	16.0	2.4
Mountain	3.8	2.6	3.0	1.8	14.6
Pacific	12.6	6.2	7.5	4.1	70.0
Unknown	1.5	1.4	1.4	2.7	0.3

In Table 1-26, it is obvious that motor carriers have a near monopoly, 82.8 percent, of the total transportation of printed matter. However, the air mode has a significant share of at least one commodity, i.e., SIC 27911 "Products of Service Industries for the Printing Trades." This SIC number consists of products of typesetting including advertisement typesetting, hand composition, machine composition, photocomposition, etc. The high value, urgency, and low weight of such products provides an excellent opportunity for air transport.

Printed material not elsewhere classified (NEC) occupies the second position of importance for air transport of printed matter with 10.7 percent. This classification is somewhat related to "Products of Service Industries for the Printing Trade" as it includes micropublishing. Also included are comparatively high-value commodities such as atlases, maps, sheet music, and technical manuals or papers.

Origin/destination of printed products: Table 1-27 (Reference 1-11) and the chart below provide information on the origin and destination of printed products. More than 43 percent of all printed products in 1972 were destined for states comprising the Middle Atlantic and East North Central division.

PERCENT DISTRIBUTION OF PRINTED PRODUCTS
BY REGION OF ORIGIN, 1972



Fresh fruits and vegetables: The commodity fresh fruits and vegetables is one of the nine major commodities transported by air. As this commodity is not a manufactured product, it was not included in the 1972 Census of Transportation. For this reason, other sources of information were located. Primary of these sources are the publications of the United States Department of Agriculture, References 1-12 and 1-4.

Since California accounts for approximately 45 percent of total produce industry shipments, it was selected as a representative origin source. Reference 1-4 provides the percentage distribution of air shipments originating from either Los Angeles or San Francisco while Reference 1-12 provides the destination of produce shipments by state and by mode. Produce selected for analysis are artichokes, cherries, grapes, lettuce, strawberries, miscellaneous commodities, and miscellaneous oriental vegetables. These seven commodities accounted for 89 percent or more of all air-shipped commodities originating in California from 1972 through 1976 as shown in Table 1-28.

TABLE 1-28

AIR SHIPMENTS OF SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES, 1972 - 1976

Commodity	1972		1973		1974		1975		1976	
	Billing Weight 1000 kg	Percent of Total	Billing Weight 1000 kg	Percent of Total	Billing Weight 1000 kg	Percent of Total	Billing Weight 1000 kg	Percent of Total	Billing Weight 1000 kg	Percent of Total
Artichokes	1 227	3.37	947	2.35	1 362	2.83	1 122	2.81	890	2.09
Cherries	1 716	4.71	2 167	5.38	1 070	2.22	1 268	3.17	990	2.33
Grapes	590	1.61	605	1.50	220	0.45	331	0.83	1 098	2.58
Lettuce	2 303	6.32	4 871	12.10	1 411	2.94	2 067	5.18	1 530	3.60
Miscellaneous Commodities	8 943	24.56	9 947	24.72	21 970	45.80	14 473	36.28	19 035	44.88
Miscellaneous Oriental Vegetables	1 374	3.77	2 003	4.97	283	0.58	1 077	2.69	1 859	4.38
Strawberries	17 458	47.98	15 646	38.89	17 958	37.44	16 249	40.71	15 289	36.05
Subtotal	33 613	92.32	36 186	89.91	44 274	92.26	36 581	91.67	40 691	95.91
All Other	2 800	7.68	4 054	10.09	3 714	7.74	3 327	8.33	1 738	4.09
TOTAL.....	36 413	100.00	40 240	100.00	47 988	100.00	39 908	100.00	42 429	100.00

(References 1-4 and 1-12). The data of Table 1-28 show that California produce shipped by air in 1976 was the second-best year of the 5 years studied exceeded only by the air shipments of 1974. Available statistics from 1965 show that 1974 and 1976 were the best years in regard to total amount shipped in the 12-year period. The Table 1-29 (References 1-4 and 1-12) presents the percent change by total and by commodity. During the 5-year period, total air shipments increased every year with the exception of 1974-1975. In this period of general business recession, air shipments decreased 17 percent.

Of the seven commodities analyzed, significant annual variations in the percent of total can be observed. For example, strawberries accounted for 48 percent of the total in 1972 and 36 percent in 1976. Such changes in share could have many causes, among them consumer demand, crop availability, and competitive modes of transportation. Some individual commodities experience extreme increases or decreases year by year. This characteristic is especially noticeable in regard to grapes and miscellaneous oriental vegetables. The latter commodity decreased 86 percent from 1973 to 1974, then increased 279 percent from 1974 to 1975. Air shipments of strawberries are the most stable of the commodities analyzed. Although experiencing increases and decreases, they are much smaller than with previously mentioned commodities. During the 5-year period, the number of kilograms shipped ranged from 15.2 million to 17.9 million kilograms.

The 10 city-pairs accounting for the major traffic flow by air were used for this portion of the study. These city pairs were:

LAX-NYC/NYC-LAX
LAX-CHI/CHI-LAX
SFO-NYC/NYC-SFO
SFO-CHI/CHI-SFO
NYC-CHI/CHI-NYC

TABLE 1-29

SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES,
PERCENT CHANGE OF AIR SHIPMENTS, 1972-1976

Commodity	1972	1973		1974		1975		1976	
	Billing Weight 1000 kg	Billing Weight 1000 kg	Percent Change	Billing Weight 1000 kg	Percent Change	Billing Weight 1000 kg	Percent Change	Billing Weight 1000 kg	Percent Change
Artichokes	1 227	947	(23)	1 362	43	1 122	(18)	890	(21)
Cherries	1 716	2 167	26	1 070	(51)	1 268	18	990	(22)
Grapes	590	605	2	200	(64)	331	51	1 098	231
Lettuce	2 303	4 971	111	1 411	(71)	2 067	46	1 530	(26)
Miscellaneous Commodities	8 943	9 947	11	21 970	121	14 473	(34)	19 035	31
Miscellaneous Oriental Vegetables	1 374	2 003	46	283	(86)	1 071	279	1 859	73
Strawberries	17 458	15 646	(10)	17 958	15	16 249	(10)	15 289	(6)
Subtotal	33 613	36 186	8	44 274	22	36 581	(17)	40 691	11
All Other	2 800	4 054	45	3 714	(8)	3 327	(10)	1 738	(48)
TOTAL......	36 413	40 240	11	47 988	19	39 908	(17)	42 429	6

As might be expected with fresh fruits and vegetables, there was no traffic flow for:

NYC-SFO
NYC-LAX
CHI-SFO
CHI-LAX
NYC-CHI
CHI-NYC

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The source data, as received, had to be combined to provide origin city-pairs. The following procedural steps were undertaken to provide tables for analysis:

- Selected commodities by city-pairs were located in the appropriate regional book in Reference 1-12. These data are presented in equivalent carloads. Converting these weights to tonnes for the tabular data consisted of multiplying the commodity billing weight per carloads by the number of carloads and dividing by 2200 to obtain metric tonnes
- Reference 1-12 provides data by origin state and destination city. Therefore, it was necessary to refer to Reference 1-4 to determine whether the city origin was SFO or LAX using the following percentage table by commodity and city:

	1972		1976	
Commodity	%LAX	%SFO	%LAX	%SFO
Artichokes	0	100	1	99
Cherries	2	98	2	98
Grapes	79	21	97	3
Lettuce	69	31	88	12
Strawberries	40	60	49	51
Miscellaneous Commodities (including Fruits and Vegetables NEC)	60	40	52	48
Miscellaneous Oriental Vegetables	57	43	39	61

Figure 1-26 (References 1-4 and 1-12) provides a comparison of the change in mode shares for all California produce shipped to Chicago and New York City between the years 1972 and 1976. Detailed statistics including the amount of tonnes and percent change are shown in Table 1-30 (References 1-4 and 1-12). In this comparatively short period of time, the railroads have had to relinquish a major share of market (72 to 83 percent) to the trucking industry for each of the four destinations. This change in mode share for the city-pair LAX-NYC is depicted in Figure 1-27 (References 1-4 and 1-12).

With the exception of the city-pair SFO-NYC where the percent share of transportation for air has increased from 11 to 17 percent, the three other city-pairs have remained relatively constant with the largest percentage change being a 2-percent decrease for SFO-CHI.

Tables 1-31 through 1-34 (References 1-4 and 1-12) provide the tonnes by mode and by percent change between 1972 and 1976 for the seven selected produce commodities by city-pair. Analysis of the total air shipments indicates decreases for air in the city-pairs LAX-NYC and SFO-NYC and increases for air shipments to CHI from both California origins. The largest increase for air is 140 percent for LAX-CHI. In the SFO-NYC market, air shipments have decreased for six of the seven selected commodities. Only miscellaneous oriental vegetables increased, and this increase was a significant 160 percent.

The trucking industry's aggressive growth pattern is quite obvious in these tables. In the overwhelming majority of cases where air share of transportation has decreased, the trucking industry's share has increased.

<u>Domestic growth trends, 1968-1976</u>: Destinations selected were Boston, Chicago, Cleveland, Detroit, New York/Newark, Philadelphia, and Hawaii (total destined for Honolulu, Hilo, Maui). Source of the statistical data for this section was "Air Shipments of California Fruits and Vegetables" published by the Federal-State Market News Service. Statistical data, converted to metric tonnes, concerning air shipments of selected California fresh fruits and vegetables to major U.S. domestic destinations were prepared and tabulated for each of the years 1968-1976. Analysis of Tables 1-35 through 1-44 results in the following findings:

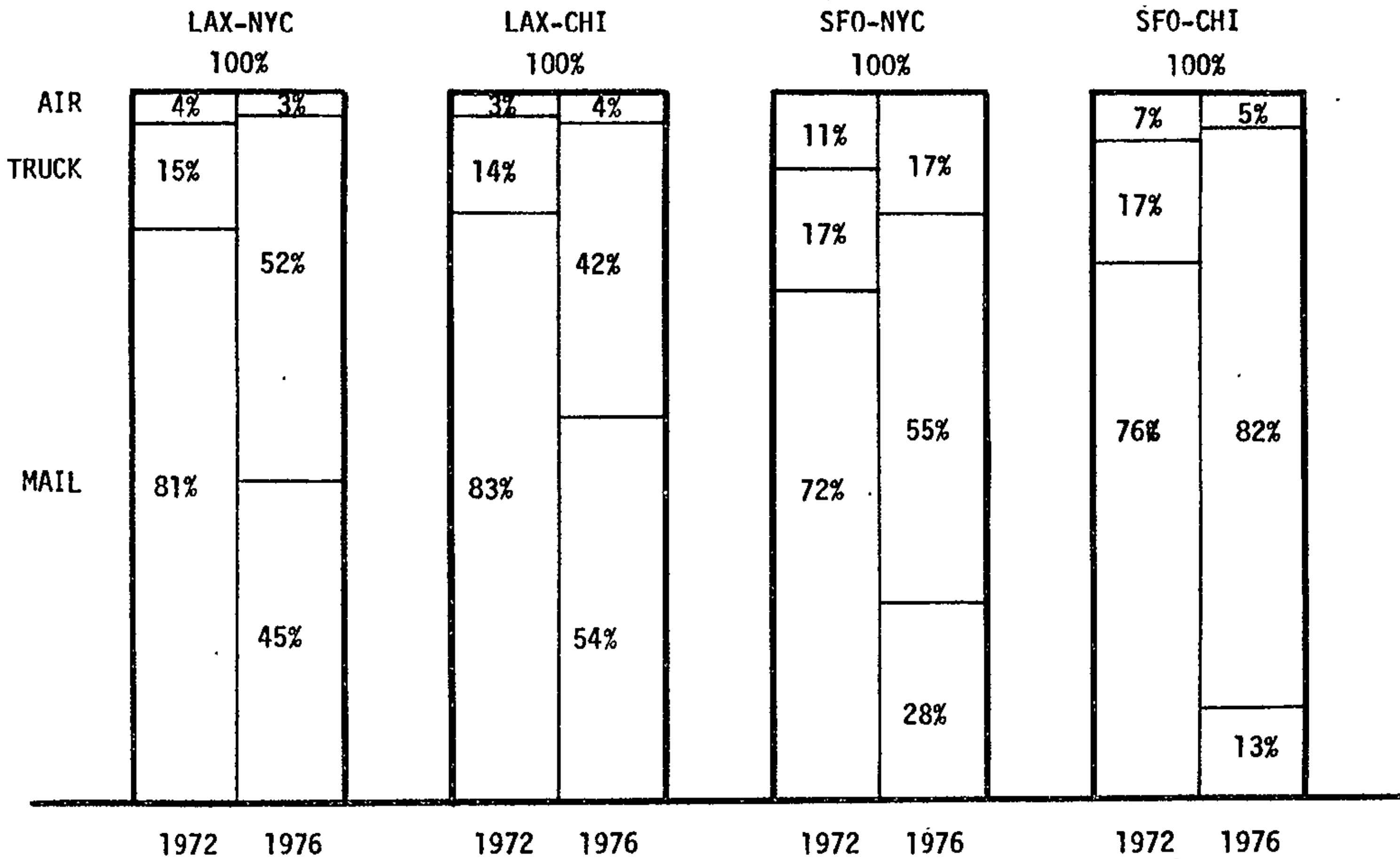

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Figure 1-26. Fresh Fruits and Vegetables - Percent Change in Transportation Mode, 1972-1976

TABLE 1-30

FRESH FRUITS AND VEGETABLE SHIPMENTS, 1972-1976

City Pair	LAX-NYC		LAX-CHI		SFO-NYC		SFO-CHI	
	Tonnes	% Total	Tonnes	% Total	Tonnes	% Total	Tonnes	% Total
1972								
Mode:								
Air	4 070	4	1 517	3	6 398	11	2 119	7
Truck	17 486	15	8 491	14	9 385	17	4 946	17
Rail	95 854	81	50 611	83	40 279	72	21 765	76
Total	117 410	100	60 619	100	56 062	100	28 830	100
1976								
Mode:								
Air	3 574	3	3 640	4	4 722	17	2 382	5
Truck	72 958	52	35 065	42	14 818	55	35 817	82
Rail	64 578	45	45 879	54	7 627	28	5 610	13
Total	141 110	100	84 584	100	27 167	100	43 809	100

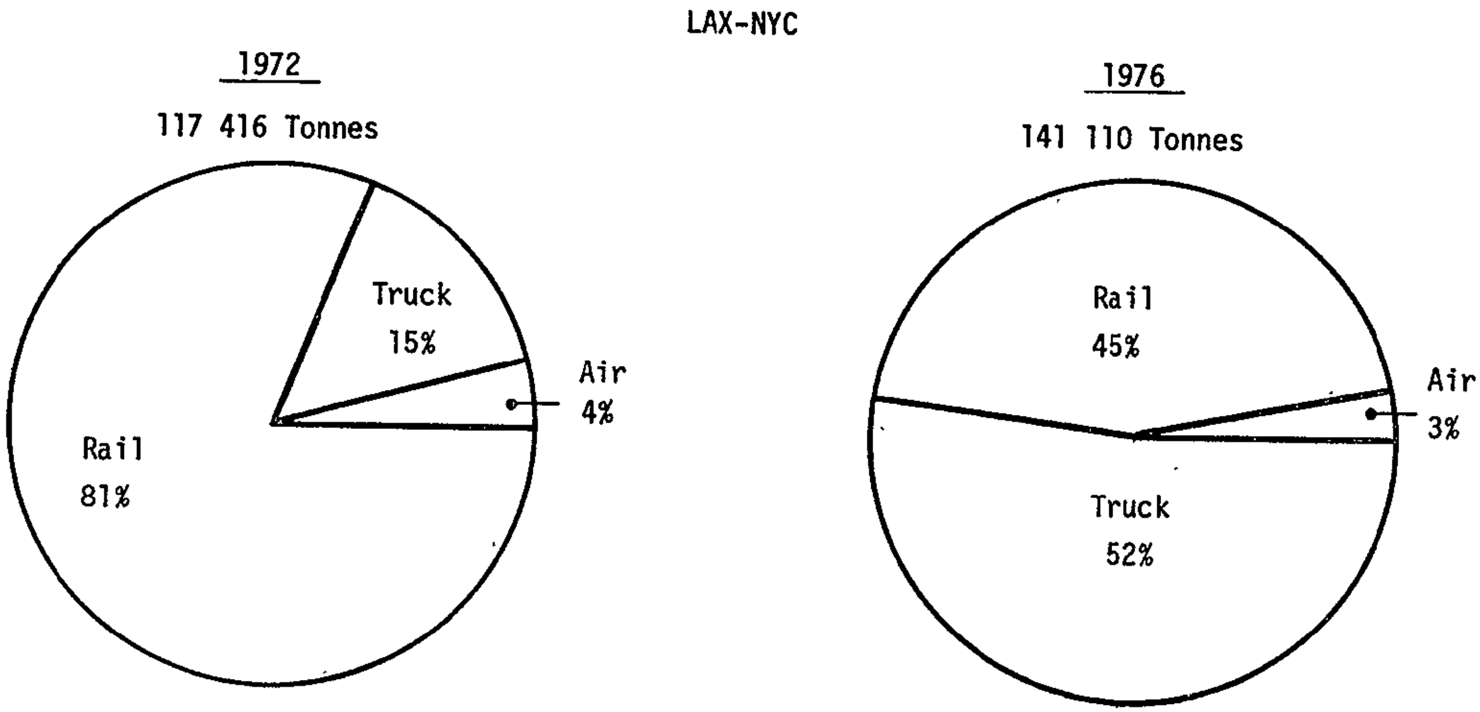


Figure 1-27. Fresh Fruits and Vegetables, 1972-1976

TABLE 1-31

SHIPMENTS OF MAJOR CALIFORNIA FRESH FRUITS AND VEGETABLES, 1972-1976 CITY-PAIR: LAX-NYC

Commodity	Air			Truck			Rail			Total		
	1972 Tonnes	1976 Tonnes	% Change	1972 Tonnes	1976 Tonnes	% Change	1972 Tonnes	1976 Tonnes	% Change	1972 Tonnes	1976 Tonnes	% Change
Lettuce	229.9	146.4	-31	12 805.4	57 540.1	349	66 336.6	46 462.0	-30	79 371.9	104 148.5	31
Strawberries	2 269.8	2 468.7	9	1 380.9	1 867.5	35	0	0	0	3 650.6	4 336.2	19
Cherries	23.2	13.1	-43	0	65.5	100	14.5	1.5	-90	37.7	80.1	112
Artichokes	0	5.7	100	0	10.2	100	0	6.8	100	0	22.7	100
Grapes	134.4	228.6	70	3 158.4	13 010.9	312	29 484.0	18 107.7	-39	32 776.8	31 347.2	-4
Miscellaneous Oriental Vegetables	402.6	504.3	25	0	0	0	8.2	0	-100	410.7	504.3	23
Miscellaneous Commodities (Including Fruits and Vegetables NEC)	1 010.0	207.3	-79	141.2	463.6	228	10.9	0	-100	1 162.0	670.9	-42
TOTAL	4 069.9	3 574.1	-12	17 485.9	72 957.8	317	95 854.2	64 578.0	-33	117 409.7	141 109.9	20

TABLE 1-32

SHIPMENTS OF MAJOR CALIFORNIA FRESH FRUITS AND VEGETABLES, 1972-1976
CITY-PAIR: SFO-NYC

Commodity	Air			Truck			Rail			Total		
	1972 Tonnes	1976 Tonnes	% Change	1972 Tonnes	1976 Tonnes	% Change	1972 Tonnes	1976 Tonnes	% Change	1972 Tonnes	1976 Tonnes	% Change
Lettuce	104.5	20.9	-80	5 753.8	7 845.4	36	29 803.4	6 335.7	-79	35 661.7	14 202.0	-60
Strawberries	3 404.6	2 570.2	-25	2 071.3	1 944.4	-6	0	0	0	5 476.0	4 514.6	-18
Cherries	1 165.8	612.5	-47	275.5	3 208.3	1 064	391.5	56.7	-86	1 832.8	3 877.5	112
Artichokes	711.9	528.2	-26	350.3	989.5	182	2 226.1	674.8	-70	3 288.3	2 192.5	-33
Grapes	33.6	6.7	-80	840.0	403.4	-52	7 845.6	559.8	-93	8 719.2	969.9	-89
Miscellaneous Oriental Vegetables	304.6	790.5	160	0	0	0	5.4	0	-100	310.1	790.5	155
Miscellaneous Commodities (Including Fruits and Vegetables NES)	673.3	192.7	-71	94.1	427.2	354	7.2	0	-100	774.7	619.9	-20
TOTAL	6 298.3	4 721.7	-26	9 385.0	14 818.2	58	40 279.2	7 627.0	-81	56 062.8	27 166.9	-52

TABLE 1-33

SHIPMENTS OF MAJOR CALIFORNIA FRESH FRUITS AND VEGETABLES, 1972-1976 CITY-PAIR: LAX-CHI

Commodity	Air			Truck			Rail			Total		
	1972 Tonnes	1976 Tonnes	% Change	1972 Tonnes	1976 Tonnes	% Change	1972 Tonnes	1976 Tonnes	% Change	1972 Tonnes	1976 Tonnes	% Change
Lettuce	14.6	938.9	6 331	5 797.7	23 829.0	311	41 791.6	39 396.5	-6	47 603.9	64 164.4	35
Strawberries	1 010.3	1 867.5	85	875.8	970.1	11	0	0	0	1 886.0	2 837.6	50
Cherries	4.4	1.5	-66	7.3	27.7	279	2.9	0	-	14.5	29.2	100
Artichokes	0	1.1	100	0	3.4	100	0	0	-	0	4.5	100
Grapes	65.6	749.7	1 043	1 658.2	10 012.0	504	8 480.0	6 473.5	-24	10 204.3	17 235.2	69
Miscellaneous Oriental Vegetables	140.0	16.4	-88	0	175.8	100	0	0	0	140.0	192.2	37
Miscellaneous Commodities (Including Fruits and Vegetables NEC)	282.4	65.4	-77	152.2	47.3	-69	336.7	9.1	-197	771.0	121.8	-84
TOTAL	1 517.2	3 640.5	140	8 401.0	35 065.3	313	50 611.2	45 879.1	-9	60 619.7	84 584.9	39

TABLE 1-34

SHIPMENTS OF MAJOR CALIFORNIA FRESH FRUITS AND VEGETABLES, 1972-1976
CITY-PAIR: SFO-CHI

Commodity	Air			Truck			Rail			Total		
	1972 Tonnes	1976 Tonnes	% Change	1972 Tonnes	1976 Tonnes	% Change	1972 Tonnes	1976 Tonnes	% Change	1972 Tonnes	1976 Tonnes	% Change
Lettuce	6.3	127.6	1 925	2 604.1	32 494.1	1 148	18 776.6	5 371.8	-71	21 387.0	37 993.5	78
Strawberries	1 515.4	1 944.4	28	1 313.7	1 009.4	-23	0	0	0	2 829.0	2 953.8	4
Cherries	184.2	42.3	-77	326.3	1 372.0	320	171.1	29.2	-82	681.5	1 443.5	112
Artichokes	101.7	157.9	55	158.2	314.7	99	339.0	0	-100	598.9	472.6	-21
Grapes	18.5	23.5	27	441.8	309.3	-30	2 254.6	200.0	-91	2 714.9	532.8	-80
Miscellaneous Oriental Vegetables	104.7	24.5	-77	0	274.0	100	0	0	0	104.7	298.5	185
Miscellaneous Commodities (Including Fruits and Vegetables NEC)	188.2	61.8	-67	101.4	43.6	-57	224.4	9.1	-96	514.0	114.5	-78
TOTAL	2 119.0	2 382.0	12	4 945.5	35 817.1	624	21 765.7	5 610.1	-74	28 830.0	43 809.2	52

TABLE 1-35
AIR SHIPMENTS OF SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES TO MAJOR U.S. DOMESTIC DESTINATIONS, 1968

Commodity	Boston		Chicago		Cleveland		Detroit		New York/Newark		Philadelphia		Hawaii		Total	
	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total
Artichokes	50	3.1	20	0.4	-	-	3	0.2	339	3.7	20	1.1	-	-	432	2.1
Cherries	128	7.9	94	2.2	51	4.3	39	2.2	729	7.8	132	7.6	4	0.9	1 177	5.7
Grapes	37	2.3	35	0.8	17	1.4	27	1.5	40	0.4	12	0.7	7	1.6	175	.9
Lettuce	-	-	3	0.1	-	-	-	-	295	3.2	10	0.6	36	8.1	344	1.7
Miscellaneous Commodities	8	0.5	38	0.8	-	-	-	-	144	1.6	2	0.1	354	79.1	546	2.7
Miscellaneous Oriental Vegetables	63	3.9	83	1.8	3	0.3	40	2.2	706	7.6	3	0.2	-	-	898	4.4
Strawberries	1 333	82.3	4 228	93.9	1 104	94.0	1 688	93.9	7 032	75.7	1 564	89.7	46	10.3	16 995	82.5
TOTALS	1 619	100.0	4 501	100.0	1 175	100.0	1 797	100.0	9 285	100.0	1 743	100.0	447	100.0	20 567	100.0

TABLE 1-36

AIR SHIPMENTS OF SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES TO MAJOR U.S. DOMESTIC DESTINATIONS, 1969

Commodity	Boston		Chicago		Cleveland		Detroit		New York/Newark		Philadelphia		Hawaii		Total	
	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total
Artichokes	35	1.4	-	-	5	0.4	-	-	34	0.5	7	0.5	-	-	81	0.4
Cherries	122	4.9	155	4.6	54	4.6	42	2.1	760	10.4	149	9.7	3	0.3	1 285	6.9
Grapes	29	1.2	27	0.8	20	1.7	32	1.6	64	0.9	18	1.2	22	2.1	212	1.1
Lettuce	71	2.8	31	0.9	-		21	1.1	204	2.8	50	3.2	48	4.7	425	2.2
Miscellaneous Commodities	41	1.6	56	1.7	13	1.1	2	0.1	648	8.8	-	-	930	90.6	16 90	8.9
Miscellaneous Oriental Vegetables	139	5.6	232	6.9	4	0.3	75	3.8	584	7.9	4	0.2	-		1 038	5.5
Strawberries	2 065	82.5	2 846	85.1	1 091	91.9	1 791	91.3	5 035	68.7	1 311	85.2	24	2.3	14 163	75.0
TOTALS	2 502	100.0	3 347	100.0	1 187	100.0	1 963	100.0	7 329	100.0	1 539	100.0	1 027	100.0	18 894	100.0

TABLE 1-37

AIR SHIPMENTS OF SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES TO MAJOR U.S. DOMESTIC DESTINATIONS, 1970

Commodity	Boston		Chicago		Cleveland		Detroit		New York/Newark		Philadelphia		Hawaii		Total	
	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total
Artichokes	11	0.4	-	-	-	-	1	-	164	2.2	6	0.3	-	-	182	.9
Cherries	122	4.3	134	4.4	68	6.2	73	2.9	762	10.1	225	13.1	1	0.2	1 384	7.2
Grapes	30	1.1	25	0.8	12	1.1	119	4.8	92	1.2	186	10.9	10	1.9	474	2.5
Lettuce	44	1.5	33	1.1	15	1.4	342	13.8	430	5.7	8	0.5	15	2.9	887	4.6
Miscellaneous Commodities	56	1.9	133	4.3	8	0.7	28	1.1	490	6.5	8	0.5	449	86.7	1 172	6.1
Miscellaneous Oriental Vegetables	205	7.2	409	13.3	2	0.2	190	7.7	638	8.5	7	0.4	1	0.2	1 452	7.6
Strawberries	2 387	83.6	2 334	76.1	984	90.4	1 722	69.7	4 936	65.8	1 272	74.3	42	8.1	13 677	71.1
TOTALS	2 855	100.0	3 068	100.0	1 089	100.0	2 475	100.0	7 512	100.0	1 711	100.0	518	100.0	19 228	100.0

TABLE 1-38

AIR SHIPMENTS OF SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES TO MAJOR U.S. DOMESTIC DESTINATIONS, 1971

Commodity	Boston		Chicago		Cleveland		Detroit		New York/Newark		Philadelphia		Hawaii		Total	
	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total
Artichokes	81	2.9	46	1.3	5	0.1	1	-	770	7.6	36	2.1	-		939	3.1
Cherries	209	7.5	164	4.6	57	1.4	80	4.0	1 458	14.4	122	7.1	6	0.1	2 096	6.9
Grapes	30	1.1	69	2.0	2 424	60.1	64	3.2	216	2.1	49	2.9	55	0.9	2 907	9.5
Lettuce	21	0.7	15	0.4	2	-	290	14.6	496	4.9	4	0.2	501	7.9	1 329	4.3
Miscellaneous Commodities	171	6.1	292	8.2	4	0.1	74	3.7	588	5.8	38	2.2	5 667	89.6	6 834	22.3
Miscellaneous Oriental Vegetables	82	2.9	60	1.7	-		59	3.0	581	5.7	-		1	-	783	2.6
Strawberries	2 206	78.8	2 901	81.8	1 544	38.3	1 424	71.5	6 036	59.5	1 469	85.5	94	1.5	15 674	51.3
TOTALS	2 800	100.0	3 547	100.0	4 036	100.0	1 992	100.0	10 145	100.0	1 718	100.0	6 324	100.0	30 562	100.0

TABLE 1-39
AIR SHIPMENTS OF SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES TO MAJOR U.S. DOMESTIC DESTINATIONS, 1972

Commodity	Boston		Chicago		Cleveland		Detroit		New York/Newark		Philadelphia		Hawaii		Total	
	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total
Artichokes	219	8.2	92	2.6	6	0.4	-	-	711	7.1	103	6.9	-	-	1 131	4.5
Cherries	126	4.7	180	5.1	48	3.3	35	2.8	1 184	11.8	39	2.6	23	0.5	1 635	6.5
Grapes	32	1.2	76	2.2	13	0.9	25	2.0	159	1.6	15	1.0	3	0.1	323	1.3
Lettuce	4	0.1	21	0.6	4	0.3	10	0.8	317	3.2	10	0.7	88	1.9	454	1.8
Miscellaneous Commodities	163	6.1	339	9.6	15	1.0	187	14.8	1 286	12.9	2	0.1	4 290	92.0	6 282	25.1
Miscellaneous Oriental Vegetables	71	2.7	224	6.4	1	0.1	131	10.3	695	6.9	5	0.3	162	3.5	1 289	5.1
Strawberries	2 063	77.0	2 593	73.5	1 352	94.0	875	69.3	5 653	56.5	1 318	88.4	96	2.0	13 950	55.7
TOTALS	2 678	100.0	3 525	100.0	1 439	100.0	1 263	100.0	10 005	100.0	1 492	100.0	4 662	100.0	25 064	100.0

TABLE 1-40

AIR SHIPMENTS OF SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES TO MAJOR U.S. DOMESTIC DESTINATIONS, 1973

Commodity	Boston		Chicago		Cleveland		Detroit		New York/Newark		Philadelphia		Hawaii		Total	
	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total
Artichokes	145	5.9	116	3.3	16	1.4	-	-	517	4.5	108	4.8	-	-	902	3.5
Cherries	222	9.1	225	6.3	93	8.2	149	9.9	1 261	11.1	80	3.5	10	0.3	2 040	7.9
Grapes	158	6.4	52	1.5	20	1.8	32	2.1	134	1.2	30	1.3	-	-	426	1.6
Lettuce	21	0.9	35	1.0	-	-	10	0.7	2 132	18.7	119	5.2	25	0.7	2 342	9.0
Miscellaneous Commodities	192	7.8	339	9.5	11	1.0	156	10.4	1 834	16.1	210	9.2	3 474	95.0	6 216	24.0
Miscellaneous Oriental Vegetables	84	3.4	371	10.3	19	1.7	414	27.6	102	0.9	642	28.3	91	2.5	1 723	6.6
Strawberries	1 632	66.5	2 431	68.1	967	85.9	739	49.3	5 399	47.5	1 082	47.7	58	1.5	12 308	47.4
TOTALS	2 454	100.0	3 569	100.0	1 126	100.0	1 500	100.0	11 379	100.0	2 271	100.0	3 658	100.0	25 957	100.0

TABLE 1-41
AIR SHIPMENTS OF SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES TO MAJOR U.S. DOMESTIC DESTINATIONS, 1974

Commodity	Boston		Chicago		Cleveland		Detroit		New York/Newark		Philadelphia		Hawaii		Total	
	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total
Artichokes	188	5.8	232	5.2	6	0.6	-	-	849	7.7	63	3.7	-	-	1 338	4.9
Cherries	145	4.5	190	4.3	68	6.5	78	5.2	443	4.0	96	5.6	9	0.2	1 029	3.7
Grapes	13	0.4	72	1.6	7	0.6	10	0.7	69	0.6	17	1.0	-	-	188	0.7
Lettuce	19	0.6	106	2.4	2	0.2	15	1.0	561	5.1	33	1.9	19	0.4	755	2.7
Miscellaneous Commodities	357	11.0	834	18.9	63	6.0	412	27.5	2 886	26.2	265	15.5	4 298	97.4	9 115	33.4
Miscellaneous Oriental Vegetables	5	0.1	8	0.2	5	0.5	7	0.5	248	2.3	5	0.3	-	-	278	1.0
Strawberries	2 522	77.6	2 978	67.4	895	85.6	975	65.1	5 960	54.1	1 233	72.0	89	2.0	14 652	53.6
TOTALS	3 249	100.0	4 420	100.0	1 046	100.0	1 497	100.0	11 016	100.0	1 712	100.0	4 415	100.0	27 355	100.0

TABLE 1-42
AIR SHIPMENTS OF SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES TO MAJOR U.S. DOMESTIC DESTINATIONS, 1975

Commodity	Boston		Chicago		Cleveland		Detroit		New York/Newark		Philadelphia		Hawaii		Total	
	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total
Artichokes	158	6.6	146	2.7	25	1.8	2	0.1	660	5.9	41	2.0	-	-	1 032	3.5
Cherries	119	4.9	125	2.3	55	3.9	86	5.4	708	6.4	46	2.2	17	0.3	1 156	3.9
Grapes	23	0.9	107	2.0	18	1.3	8	0.5	122	1.1	28	1.3	5	0.1	311	1.1
Lettuce	4	0.2	405	7.4	255	18.0	81	5.0	163	1.5	394	19.0	23	0.4	1 325	4.5
Miscellaneous Commodities	484	20.1	1 308	24.0	356	25.1	459	28.6	2 959	26.5	395	19.0	5 146	97.6	11 107	37.9
Miscellaneous Oriental Vegetables	112	4.7	26	0.5	20	1.4	53	3.3	906	8.1	3	0.1	4	0.1	1 124	3.8
Strawberries	1 506	62.6	3 322	61.1	687	48.5	916	57.1	5 625	50.5	1 168	56.4	76	1.5	13 300	45.3
TOTALS	2 406	100.0	5 439	100.0	1 416	100.0	1 605	100.0	11 143	100.0	2 075	100.0	5 271	100.0	29 355	100.0

TABLE 1-43

AIR SHIPMENTS OF SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES TO MAJOR U.S. DOMESTIC DESTINATIONS, 1976

Commodity	Boston		Chicago		Cleveland		Detroit		New York/Newark		Philadelphia		Hawaii		Total	
	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total	Tonnes	Percent of Total
Artichokes	82	3.5	154	2.1	9	1.2	2	0.1	526	5.7	32	3.0	-	-	805	2.8
Cherries	104	4.4	145	2.0	55	7.2	87	4.0	448	4.9	70	6.6	3	-	912	3.2
Grapes	35	1.5	752	10.5	32	4.2	27	1.2	159	1.7	17	1.6	20	0.4	1 042	3.7
Lettuce	2	0.1	1 045	14.6	4	0.5	177	8.1	148	1.6	27	2.6	81	1.4	1 484	5.2
Miscellaneous Commodities	488	20.7	1 230	17.1	141	18.4	966	44.1	1 569	17.1	263	24.8	5 491	96.3	10 148	35.7
Miscellaneous Oriental Vegetables	317	13.5	54	0.8	-	-	131	6.0	1 290	14.1	-	-	3	-	1 795	6.3
Strawberries	1 327	56.3	3 802	52.9	525	68.5	799	36.5	5 035	54.9	651	61.4	109	1.9	12 248	43.1
TOTALS	2 355	100.0	7 182	100.0	766	100.0	2 189	100.0	9 175	100.0	1 060	100.0	5 707	100.0	28 434	100.0

TABLE 1-44

PERCENTAGE DISTRIBUTION OF AIR SHIPMENTS FOR SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES TO MAJOR U.S. DOMESTIC DESTINATIONS, 1968 - 1976

	1968		1969		1970		1971		1972		1973		1974		1975		1976	
Destinations	Tonnes	Percent Of Total	Tonnes	Percent Of Total	Tonnes	Percent Of Total	Tonnes	Percent Of Total	Tonnes	Percent Of Total	Tonnes	Percent Of Total	Tonnes	Percent Of Total	Tonnes	Percent Of Total	Tonnes	Percent Of Total
Boston	1 619	7.9	2 502	13.2	2 855	14.8	2 800	9.2	2 678	10.7	2 454	9.5	3 249	11.9	2 406	8.2	2 355	8.3
Chicago	4 501	21.9	3 347	17.7	3 068	15.9	3 547	11.6	3 525	14.1	3 569	13.7	4 420	16.1	5 439	18.5	7 182	25.3
Cleveland	1 175	5.7	1 187	6.3	1 089	5.7	4 036	13.2	1 439	5.7	1 126	4.3	1 046	3.8	1 416	4.8	766	2.7
Detroit	1 797	8.7	1 963	10.4	2 475	12.9	1 992	6.5	1 263	5.0	1 500	5.8	1 497	5.5	1 605	5.5	2 189	7.7
New York/Newark	9 285	45.1	7 329	38.9	7 512	39.1	10 145	33.2	10 005	39.9	11 379	43.8	11 016	40.3	11 143	38.0	9 175	32.2
Philadelphia	1 743	8.5	1 539	8.1	1 711	8.9	1 718	5.6	1 492	6.0	2 271	8.8	1 712	6.3	2 075	7.1	1 060	3.7
Hawaii	447	2.2	1 027	5.4	518	2.7	6 324	20.7	4 662	18.6	3 658	14.1	4 415	16.1	5 271	17.9	5 707	20.1
Total	20 567	100.0	18 894	100.0	19 228	100.0	30 562	100.0	25 064	100.0	25 957	100.0	27 355	100.0	29 355	100.0	28 434	100.0
Total U.S. Air Shipments, All Produce	25 204		23 428		24 842		35 717		30 655		32 109		33 284		35 674		33 105	
Percent Of Total Seven Destinations		81.6		80.6		77.4		85.6		81.8		80.8		82.2		82.3		85.9

1. Strawberries averaged 76.2 percent of the total selected commodities from 1968-1970. Starting in 1971, the share decreased considerably, with the average percent share from 1971 to 1976 being 49.4 percent.

2. Miscellaneous commodities increased from a small share of the total 2.7 percent in 1968 to 22.3 percent in 1981 and has steadily increased since then to 35.7 percent in 1976. Hawaii is the primary recipient, receiving 5491 tonnes or 96.3 of the total in 1976.

3. Other than strawberries and miscellaneous commodities, the remaining five commodities analyzed do not show any consistency in growth or decline of tonnes shipped from 1968 to 1976. There are wide variations such as 513-percent increase one year to an 89-percent decrease the next. Causal factors undoubtedly include supply, demand, rates, and the amount of disposable income available.

Analysis of Table 1-45 reveals that during the time frame (1968-1976) the seven destinations accounted for an average of 80.2 percent of all fresh fruits and vegetables transported by air to U.S. domestic destinations. The percentage range during these years is small, from a low of 77.4 percent in 1970 to 85.9 percent in 1976.

The share of market held by each of the seven destinations is also shown in Table 1-45. Comparatively stable markets in regard to market share are Boston, Chicago, Cleveland, Detroit, New York, and Philadelphia. The greatest growth in share of market is Hawaii, which in 1968 accounted for 447 tonnes or 2.2 percent of the total. By 1976, the tonnage of produce air shipped to Hawaii had increased approximately 13 times to 5707 tonnes which was a 20.1 percent share of market. As might be expected, the large population centers of New York/Newark and Chicago have consistently been the largest markets. New York/Newark averaged 38.9 percent share of the market, and Chicago's average was 17.2 percent.

Table 1-46 provides the trend of shipments by destination. None of the major consumption cities show a constant trend of growth or decline. There are wide variations in tonnage by destination from year to year. For example,

TABLE 1-45

PERCENT CHANGE IN AIR SHIPMENTS OF SELECTED CALIFORNIA FRESH FRUITS AND VEGETABLES TO MAJOR U.S. DOMESTIC DESTINATIONS, 1968 - 1976

	1968	1969		1970		1971		1972		1973		1974		1975		1976	
Destination	Tonnes	Tonnes	Percent Change	Tonnes	Percent Change	Tonnes	Percent Change	Tonnes	Percent Change	Tonnes	Percent Change	Tonnes	Percent Change	Tonnes	Percent Change	Tonnes	Percent Change
Boston	1 619	2 502	54	2 855	14	2 800	(2)	2 678	(4)	2 454	(8)	3 249	(32)	2 406	(26)	2 355	(2)
Chicago	4 501	3 347	(26)	3 068	(8)	3 547	16	3 525	(1)	3 569	1	4 420	24	5 439	23	7 182	32
Cleveland	1 175	1 187	1	1 089	(8)	4 036	271	1 439	(64)	1 126	(22)	1 046	(7)	1 416	35	766	(46)
Detroit	1 797	1 963	9	2 475	26	1 992	(20)	1 263	(37)	1 500	19	1 497	0	1 605	7	2 189	36
New York/ Newark	9 285	7 329	(21)	7 512	3	10 145	35	10 005	(1)	11 379	14	11 016	(3)	11 143	1	9 175	(18)
Philadelphia	1 743	1 539	(12)	1 711	11	1 718	0	1 492	(13)	2 271	52	1 712	(25)	2 075	21	1 060	(49)
Hawaii	447	1 027	130	518	(50)	6 324	1 121	4 662	(26)	3 658	(22)	4 415	21	5 271	19	5 707	8

TABLE 1-46

AIR SHIPMENTS OF CALIFORNIA FRESH FRUITS AND VEGETABLES TO FOREIGN COUNTRIES, 1968 - 1976

Year	Europe		South Pacific/ Orient 1/		Hong Kong		Japan		Other 2/		Total Export	
	Tonnes	Percent Change	Tonnes	Percent Change	Tonnes	Percent Change	Tonnes	Percent Change	Tonnes	Percent Change	Tonnes	Percent Change
1968	1 098	-	951	-	-	-	-	-	36	-	2 085	-
1969	1 087	(1)	1 917	102	-	-	-	-	18	(50)	3 022	45
1970	1 427	31	2 432	27	-	-	-	-	34	90	3 893	29
1971	1 440	1	6 351	161	4 922	-	1 429	-	1 340	3 841	9 131	134
1972	2 138	48	2 337	(63)	2 135	(57)	202	(86)	1 277	(5)	5 752	(27)
1973	2 575	20	3 433	47	3 076	44	357	76	2 116	66	18 124	41
1974	1 934	(25)	1 860	(46)	577	(81)	1 283	259	10 903	415	14 697	81
1975	605	(69)	1 297	(30)	287	(50)	1 010	(21)	2 326	(79)	4 228	(71)
1976	1 459	141	220	(83)	108	(62)	112	(89)	7 636	228	9 315	120

NOTES: 1/ After 1970, this classification was discontinued and Hong Kong and Japan added to the tabulations. The data in this column from 1971-1976 is the total of Hong Kong and Japan.

2/ Previous to 1971, only Canada was in this classification. From 1971, this classification included New Zealand, Tahiti, South Africa, Canada and Guam.

although Chicago consumption increased from 4501 to 7182 tonnes, 59.6 percent, from 1968 to 1976, there have been annual negative changes as low as 26 percent to positive changes as high as 32 percent.

Again, the mainland cities in the East North Central and Middle Atlantic Regions of the United States predominate as the major areas of destination for air shipment of California fresh fruits and vegetables. This is graphically displayed in Figure 1-28 which is based on all produce commodities air shipped from California to destinations within the continental United States.

International growth trends, 1968-1976: As shown in Table 1-46 and Figure 1-29, air shipments of produce to foreign countries are characterized by extremely eratic increases and decreases in volume year-by-year.

Three geographic regions are available in the source data, Europe, South Pacific, and other. Previous to 1971, the "other" classification included only Canada. After this date, Canada, New Zealand, Tahiti, South Africa, and Guam were included. The total of the three regions and Europe are comparatively stable until 1973 and 1974.

After 6 years of constant increase, shipments to Europe declined in 1974 and 1975 with an upswing in the trend occurring in 1976. The decrease in 1974 was primarily occasioned by a decrease of 47 percent in the shipment of strawberries. Again in 1975, strawberry shipments decreased 23 percent. In addition, asparagus volume to Europe decreased 65 percent. A possible explanation for these decreases is the economic recession, with resultant lessening of demand for what might be considered luxury produce.

The South Pacific region steadily increased from 1968 to 1972 at which time a decline began which reduced total volume from 6351 metric tonnes to 220 tons in 1976. Cessation of combat activity in South Viet Nam could account for some of this decrease in the years 1974 and 1975. However, the increase in purchasing power in several countries included in the South Pacific Region would seem to have increased the demand for produce rather than decrease it. Therefore, some other explanation seems in order, and it could be either new sources of supply or containerized ocean shipments.

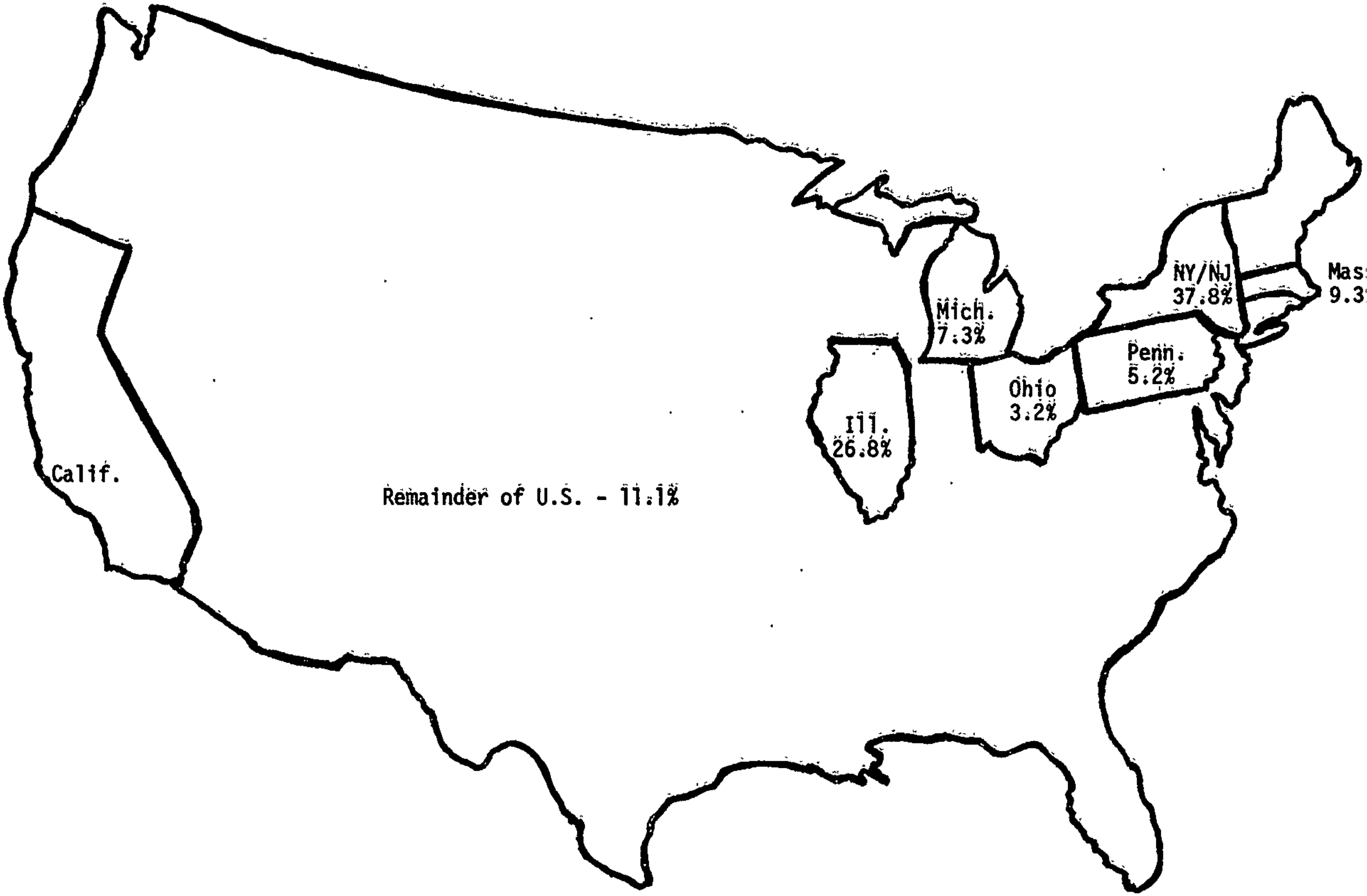


Figure 1-28. Percentage Distribution of Air-Shipped California Fresh Fruits and Vegetables Within the Continental United States, 1976

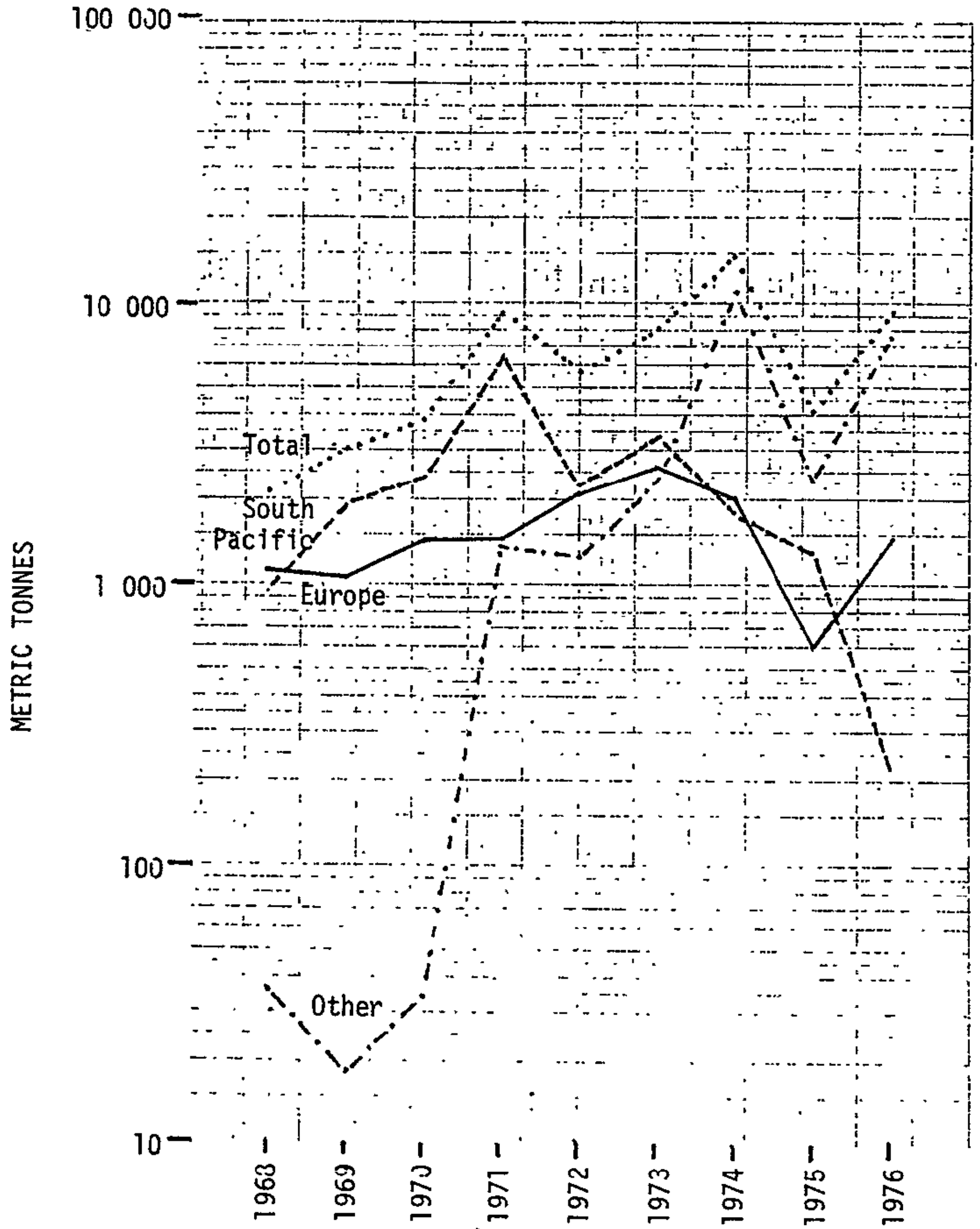


Figure 1-29. Air Shipments of California Fresh Fruits and Vegetables to Foreign Countries, 1968 - 1976

The "other" region category has shown the greatest continual increases. For example, in 1970 total shipments to this region were 34 tonnes increasing to 1340 tonnes in 1971. The primary commodity was "miscellaneous" which accounted for 91 percent or 1215 tonnes of the total. The primary country importing this classification in 1971 was Tahiti which accounted for 98 percent. The remaining 2 percent went to Guam and Canada.

In 1975, the "miscellaneous" classification accounted for 95 percent of all shipments to the "other" region. However, instead of Tahiti being the primary destination, it was Guam which received 2210 tonnes or 91 percent of the total.

In 1976, Europe and other showed an upturn in imports, with Europe showing an increase of 141 percent over 1975 and other increasing 120 percent.

Cut flower industry: Cut flowers and horticultural products (nursery stock, decorative greens, cuttings, potted plants) have been among the top 10 commodities transported by air in the domestic market since 1955. Despite this position of importance to the industry, there is a dearth of statistical data available for analysis of the market. However, information obtained in this study does indicate the importance of the industry to airfreight and reasons that air carriers should aggressively seek to improve their share of the cut flower market.

In 1969, the Society of American Florists (SAF) (Reference 1-13) conducted a survey which revealed that approximately 45 million kilograms of floral products moved by air. Based on total 1968 market data for transportation in the cut flower industry, the projected 1969 total is 139 million kilograms. Therefore, air was the preferred mode of transportation for 32 percent of this commodity.

One of the principal reasons for the use of airfreight to distribute floral products has been the substantial distance between the major growing areas (California, Washington, Oregon, Colorado, Texas, and Florida) and the major metropolitan markets in the northeast and midwest.

Certain characteristics of floral products moving by air are favorable to the airlines for the following reasons:

- Flowers move predominately during daylight hours when airline personnel are not taxed with large volumes of other freight.
- Floral products move predominately in combination passenger-cargo aircraft and, therefore, occupy cargo compartments which would otherwise have substantial amounts of unused capacity.
- Floral products move on a regular weekly and year-around basis as distinguished from emergency movements of many general commodities. This is made possible by the extensive investment made by floral growers in green houses and covered fields.
- Floral products have a low value and are not susceptible to theft or pilferage.
- Density factors are being improved by modifying floral cartons, stripping leaves (thus making room for more blooms), cutting stems shorter (thus reducing carton lengths) and using less bulky types of insulating material. As a result, gladioli shipments now have densities ranging from 11 to 15 pounds per cubic foot, carnations range from 10 to 11.5 pounds per cubic foot.

Airfreight potential in the cut flower industry is relatively insensitive to moderate increases in rates, but continual increases can have a serious impact on floral volume moving by air. This characteristic is exemplified by the effect that increases beginning in 1968 and continuing through 1973 had on Colorado floral movements through Denver International Airport. In 1970, total cut flower shipments from this airport were 3 991 908 kilograms. This amount had declined 14 percent to 3 429 239 kilograms by 1972.

From Florida, airfreight shipments of gladiolas declined from 18.94 percent of the total air and truck movements in 1969 to 15.76 percent of the total in 1971.

Similar diversions to transportation by truck are thought to have been experienced in California, although the statistics on a state-wide base are unavailable.

All available evidence indicates that rate increases will cause a widespread movement away from air in favor of refrigerated trucks. Certainly, the trucking industry could totally dominate this air-transportable commodity as their historical share has been approximately 66 to 78 percent.

Airfreight Cost Characteristics

Determining the true cost factors involved in the shipment of airfreight has been a controversial subject since airfreight shipment began. This is particularly true in the case of combination passenger and cargo operations. The allocation of cargo and passenger costs is judgmental and imprecise at best.

Most carriers agree that rate setting should be based on total operating cost plus a reasonable return on investment (12 percent). This prompted the carriers and the CAB to undertake a joint study in 1972 to determine cost causative factors of airfreight. As the allocation of combination costs was difficult, the investigation concentrated on all-cargo operations to arrive at a rate formula.

In order to undertake a cost study of airfreight, a good understanding of the CAB rate study is necessary. Then, attention must be given to aircraft characteristics and the impact of aircraft types on operating costs.

The CAB Domestic Airfreight Rate Investigation (DAFRI). - The first freight rate investigation was conducted by the CAB in 1948 to protect the "new" airfreight industry from predatory rates filed by passenger carriers at the expense of all-cargo carriers. A rigid system of minimum rates was established based on fully allocated costs and rates below the minimum were cancelled. Since this first attempt at freight rate regulation, the restrictive rate policy was relaxed somewhat giving the carriers more freedom to increase capacity by reducing rates for specific commodities, times of shipment, direction, and bypass container discounts (References 1-14 through 1-16).

The CAB plans to continue to allow the carriers wide latitude both in the kinds of discount rates they fashion and in the level of those rates. As stated in Reference 1-14, "--- the carriers will be free to continue the basic types of discounts they now offer as well as devise new pricing concepts." The rates, as a general rule, must cover noncapacity costs (terminal related) and will not exceed the ceilings established in the DAFRI ruling.

The current system of freight rate regulation (DAFRI) began in 1972. Between 1972 and 1974, the CAB conducted an in-depth investigation of cost-causative elements of airfreight. The purpose was to determine an equitable return (12 percent) in the domestic airfreight industry based on a cost-related formula which was developed during the investigations (multielement rate structure). From this investigation and the multielement rate structure, some help can be obtained in determining the more illusive cost factors involved in airfreight shipment. A brief explanation of the methodology used for the multielement rate fare structure follows:

Multielement rate structure: The multielement rate structure constructed by the CAB for the DAFRI was developed from carrier reported statistics on domestic all-cargo operations (all-cargo carriers and domestic trunk all-cargo service only). The rate, however, is applied to combination, belly-cargo, and all-cargo service.

Due to the nature of rate structuring, it is necessary to average costs and apply weighting factors to various costs. For example, capacity and non-capacity calculations used in the multielement rate structure are based on the domestic airfreight industry averages.

The multielement rate formula separates costs into capacity line-haul costs and terminal costs. To these costs are added G and A and a tax and return markup. The tax and return markup factor allows the carriers a 12-percent return on investment after taxes and is allocated in proportion to the investment in flight equipment versus terminal equipment. In 1974, investment ratio was 95.7 percent in flight equipment and 4.3 percent in terminal.

Table 1-47 shows the wide range of operating expenses by carrier and illustrates the limitations of using rate formulations for a comparative analysis of carriers or aircraft types.

Since all of the statistics and rates are stated in English units in DAFRI, the data presented under this heading (Airfreight Cost Characteristics) will be the same in order to facilitate cross referencing.

The multielement costs shown in Table 1-48 are for illustrative purposes showing functional costs by each element. For exact calculations by account number, it is suggested the reader obtain the CAB COSTING METHODOLOGY, DOMESTIC FARE STRUCTURE, Version 6 (Reference 1-17). The noncapacity terminal handling allocations were developed by the Ralph M. Parsons Company study, which is described later under a subheading entitled "Terminal Handling Costs."

The CAB calculates rates for each cost element as follows; and, as can be seen, the elements are weighted and combined to achieve a maximum fare allowable.

TABLE 1-47

COST OF FREIGHT CARRIAGE
DOMESTIC SCHEDULED SERVICE
DOMESTIC TRUNKS AND ALL CARGO CARRIERS,
CY 1972

Carrier	Freighter Capacity Expense Per RTM	Freighter Noncapacity Expense Per RTM	Total Operating Expense Per RTM
AA	$ 14.32	$ 10.28	$ 24.60
BN	16.45	19.12	35.57
CO	18.76	11.87	30.63
EA	19.59	17.51	37.10
NW	23.62	11.09	34.71
TW	13.37	11.34	24.71
UA	15.03	12.40	27.43
AI	16.78	9.08	25.86
FT	10.08	7.17	17.25
TOTAL	14.23	12.21	26.44

TABLE 1-48

MULTIELEMENT RATE STRUCTURE

Capacity Line-Haul Costs		Terminal Costs					
		Noncapacity Cost				Per CWT	
(Cost/Pound-Mile) (C)	+	(Per Shipment) (F) +	(Per Piece) (P)	+	(Capacity Portion) (F)	+	(Noncapacity Portion) (R)
COST ELEMENTS							
• Crew • Fuel • A/C Maintenance • A/C Depreciation • Insurance		• Traffic Handling			• A/C Servicing		• Reservations and Sales • Advertising and Publicity • Equipment and Facilities

X

General and Administrative Allocation

X

Tax and Return Markup Allocation

FARE CALCULATION PROCEDURE

Let W = Weight

Let D = Distance in statute miles

Let N = Number of pieces (for bypass containers N = 1)

Maximum = (C * W * D) + (S + (P*N) + (W * (F + R))

- (C * W * D): Line-haul costs
- (S + (P*N)): Terminal Handling costs
- (W * (F + R)): Other terminal and nonflight related costs

As can be seen in Table 1-49 (Reference 1-14), the aim in understanding the multielement rate structure is to gain visibility in payload-related cost-causative factors involved in airfreight transport, i.e., volume weight, pieces, commodity type, containerization, and bypass shipments. In addition, the DAFRI investigations developed a rational approach in the allocation of carrier costs by function.

Capacity line-haul costs: As illustrated previously, the CAB allocates operating costs of freight carriage into capacity and noncapacity costs. Capacity costs are obtainable from CAB Form 41 data and include items such as flight crew, fuel, maintenance (including burden), insurance, aircraft depreciation and amortization, and aircraft servicing. Although aircraft servicing costs are regarded as capacity costs, the CAB allocates these costs as terminal-related in the multielement rate structure. The CAB considers capacity line-haul costs as fixed regardless of the amount of traffic transported (Reference 1-15).

In developing the multirate multielement formula, capacity costs (specifically time-based costs) are divided into cruise-related costs and stop-related costs in order to establish the proper taper with regard to distance. These time-based costs are obtained from a sampling of service segment data. As service segment data are based on a nonstop basis, a circuitry factor and departure factor are applied to each mileage block. This was considered necessary because cargo does not always travel the shortest distance but by nature is subject to

TABLE 1-49

MULTIELEMENT CEILING FOR FREIGHT RATES,
12 MONTHS ENDED SEPTEMBER 30, 1976

Type of Traffic	Capacity Line-Haul Cost Per Pound-Mile (C)	Terminal Charge				
		Noncapacity Cost		Per Cwt		
		Per Shipment (S)	Per Piece (P)	Capacity Portion (F)	Noncapacity Portion (R)	Total
Regular Bulk Freight	0.00849¢	$ 3.79	$ 1.46	$ 6.67	$ 6.76	$ 13.43
Environmentally Controlled and Hazardous	0.00849	6.83	1.46	6.67	6.76	13.43
Live Animals	0.00849	6.83	1.46	6.67	6.76	13.43
Valuable	0.00849	11.62	1.46	6.67	6.76	13.43
Human Remains	0.00849	11.62	1.46	6.67	6.76	13.43
<u>Non-Bypass Containers</u>			<u>Per Container</u>			
B, B-2	0.00849¢	$ 3.79	$ 1.46	$ 6.67	$ 6.76	$ 13.43
LD-N	0.00849	3.79	1.46	6.67	6.76	13.43
D	0.00849	3.79	1.46	6.67	6.76	13.43
E, QD	0.00849	3.79	1.46	6.67	6.76	13.43
<u>Bypass Containers</u>						
A-1, A-2, A-3	0.00849¢	$ 3.79	$68.19	$ 6.67	$ 2.29	$ 8.96
LD-1, LD-3	0.00849	3.79	43.66	6.67	2.29	8.96
LD-7	0.00849	3.79	84.30	6.67	2.29	8.96
LD-W	0.00849	3.79	30.73	6.67	2.29	8.96

route deviations and inter- or intraline transfers. G and A is then allocated to cash expenses and a tax and return markup is applied to both capacity and noncapacity costs based on relative investment in each category. Table 1-50 (Reference 1-14, Appendix F) illustrates the capital-intensive nature of capacity costs and the percentage allocation of tax and return markup. As shown, 95.7 percent of the tax and return markup is allocated to capacity costs.

Table 1-51 (Reference 1-14) shows the resultant calculations of capacity costs after tax and return markup. These data are then regressed to calculate the capacity (line-haul based) cost of freight per freight pound-mile (0.00864¢) (Reference 1-14, Appendix N, p. 2), which is used in the multi-element rate structure. Line-haul costs are revised by the CAB on a quarterly basis and are updated using as escalation rate for the elements involved in the cost-based structure. The adjustment factor is derived by dividing year ended 9/30/76 capacity economic cost of 25.55¢ per revenue ton-mile by CY 1972 capacity expense per RTM (before markup) of 14.23¢.

Terminal costs: Noncapacity costs are costs incurred by the carrier other than flight-related expenses. It is in this area that much controversy exists as to the proper allocation of costs and, depending on the stage length, represents a significant portion of costs and potential operator cost savings. Terminal costs (largely noncapacity) have no bearing on how far the cargo

TABLE 1-50

STATEMENT OF INVESTMENT
CAPACITY-RELATED VS NONCAPACITY RELATED
DOMESTIC SCHEDULED SERVICE
DOMESTIC TRUNKS AND FLYING TIGER,
CY 1974

	Investment ($000)	Total (%)	Capacity (%)	Noncapacity (%)
Working Capital:	419 527	6.1	4.0	2.1
Flight Equipment:	6 318 122	91.7	91.7	-
Other	148 653	2.2	-	2.2
Total Investment	$6 886 302	100.0	95.7	4.3

TABLE 1-51

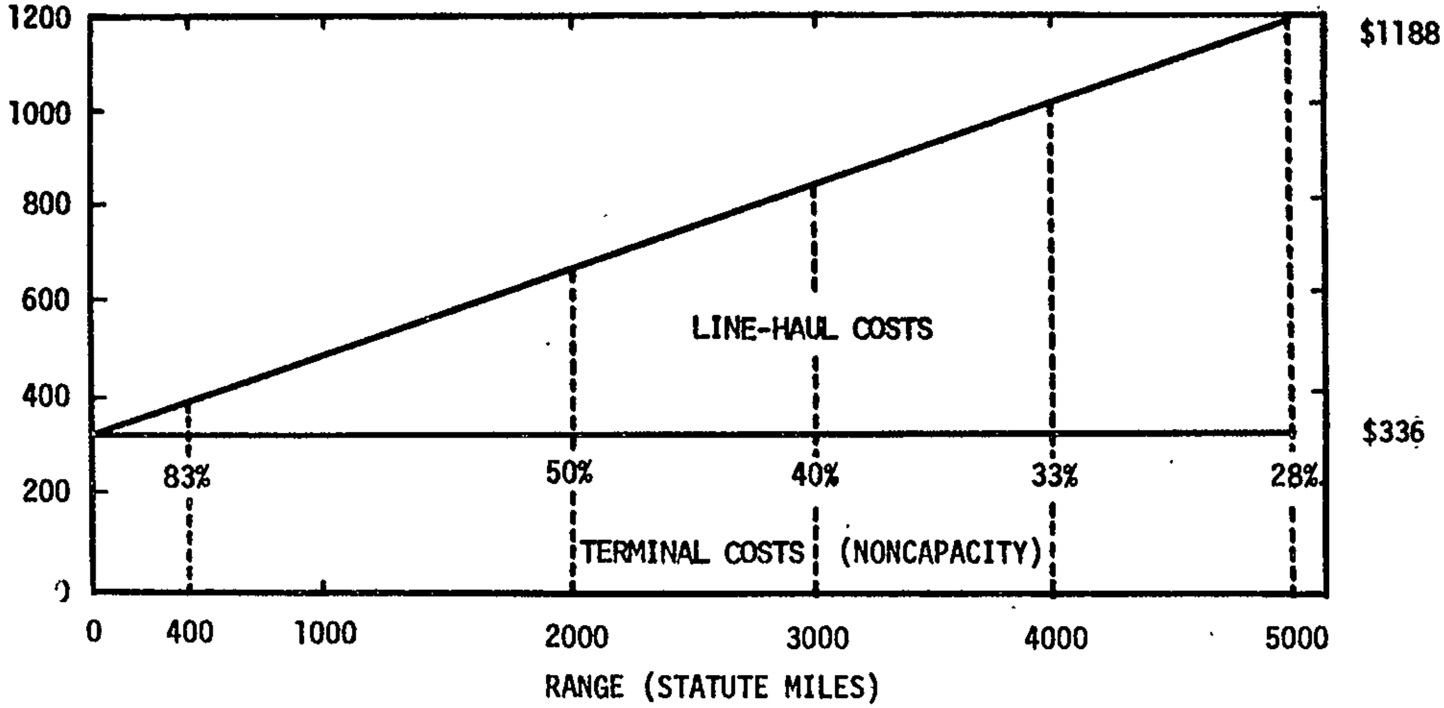
CAPACITY COST STRUCTURE ELEMENTS
UPDATED TO YEAR ENDED SEPTEMBER 1976

Mileage Block Midpoint	1972 Capacity Expense Per Ton Enplaned	Adjustment Factor	Year Ended 1976 Capacity Economic Cost/Ton Enplaned	
			Cost Based	Regressed
100	$ 84.73	1.795502	$152.13	$152.58
200	96.54		173.34	169.87
300	98.92		177.61	187.15
400	100.75		180.90	204.44
525	121.12		217.47	226.04
725	138.35		248.41	260.61
1000	198.51		356.43	308.14
1300	226.64		406.93	359.99
1600	218.43		392.19	411.84
1900	254.26		456.52	463.70
2200	294.88		529.46	515.55
2500	282.00		506.33	567.40
2800	361.34		648.79	619.25

Regression a. $135.30/Freight Ton (Constant)
b. 17.284/Freight Ton-Mile
6.765/Freight Pound
0.00864¢/Freight Pound-Mile

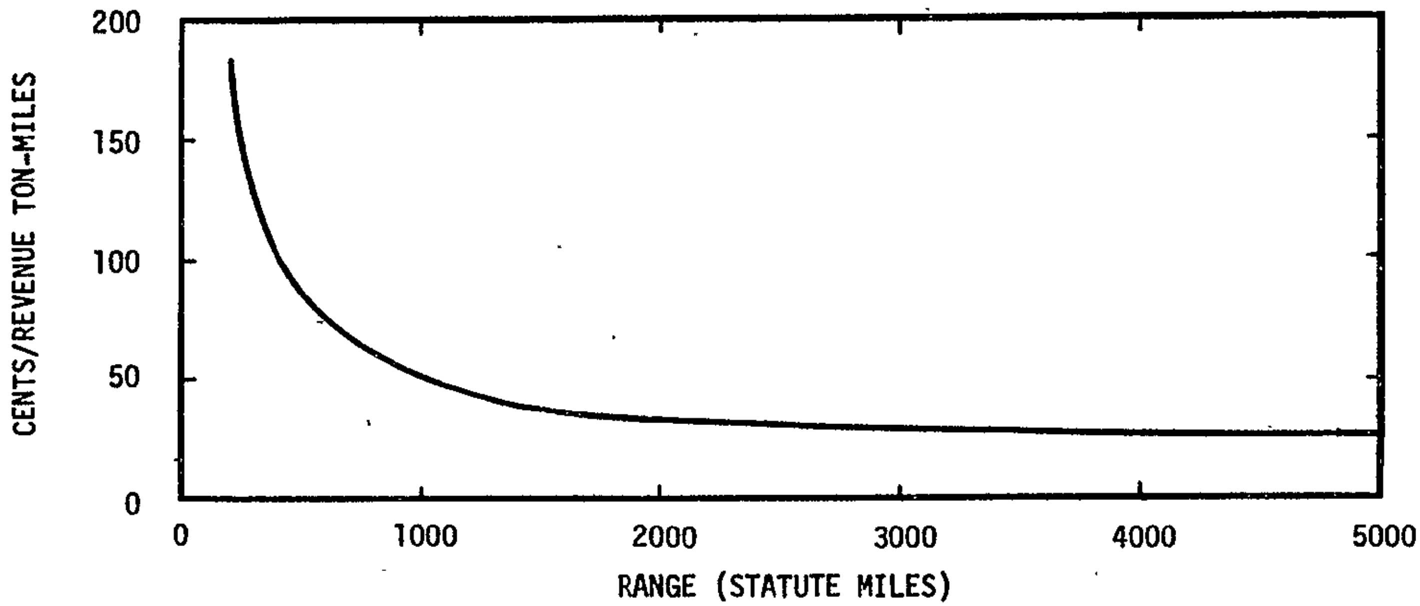
travels since it costs just as much to load and unload the aircraft for a 100-mile flight as for a 2500-mile flight. Terminal cost/CWT are largely payload or revenue related and would also remain constant with stage length (Table 1-49).

Figures 1-30 and 1-31 are the results from calculations using the multi-element rate structure (as of September 1976) in a regular bulk shipment of 2000 pounds, containing 44 pieces. This clearly shows the impact of terminal costs on short-haul segments. The data presented also include tax and return markup.



Note: 2000 pound shipment, 44 pieces

Figure 1-30. Regular Bulk Rate Fares - Multielement Rate Structure



Note: Regular bulk shipment, 2000 pounds, 44 pieces

Figure 1-31. Fare Taper by Stage Length - Multielement Rate Structure, Sept. 30, 1976

Terminal Handling Costs: In order to develop cost causative factors appropriate to terminal handling, the CAB contracted the Ralph M. Parsons Company to perform a terminal study for the rate investigation (DAFRI). This study allocated terminal costs on the basis of four airfreight characteristics: the type of shipment, volume of shipment, number of pieces per shipment, and the weight of the shipment. Due to a lack of data, the volume-related costs were converted to a weight base utilizing densities developed during the course of the study. (See Table 1-52 and References 1-18 and 1-19.)

The Parsons Company contracted with 20 airlines for a detailed study of carrier traffic services related to the handling of airfreight, mail, and express at selected terminals within the U.S. The objective was "... to measure, using industrial engineering techniques, the cost-causative elements involved in handling domestic air cargo and, on the basis of such analysis, develop cost factors and coefficients related to the number of shipments, pieces, weight density etc., ... reflecting special cost aspects of perishable, fragile, or valuable traffic ..." (Reference 1-18.)

Specifically, the study established the amount of labor (expressed in man-minutes) involved in the shipment of various commodities as general bulk, environmentally controlled and hazardous, valuable, live animals, and human remains. Additionally, the study calculated the effect of shipper-loaded containers by type of container (Table 1-49).

The multielement rate structure terminal charges include the labor-related costs as described above and also weight-related costs such as aircraft servicing, facility costs, sales, advertising, and publicity. Table 1-53 illustrates the application of the Parsons study results in the allocation of general bulk commodity noncapacity costs. The same formulation applies to other types of commodities with only variations in man-minute allocations plus weight related noncapacity costs in the case of bypass container rates.

Application of the multielement rate structure: The DAFRI investigations stand as the most comprehensive study of cost causative factors in airfreight shipments conducted to date. For comparative analysis, the calculation of terminal costs is the most significant contribution. Line-haul costs vary

TABLE 1-52

REGULAR BULK FREIGHT
NONCAPACITY UNIT COSTS

Terminal Handling Labor and Support	Unit Cost Per:		
	Shipment	Piece	Pound
Man-Minutes	5.4300	2.0900	0.0625
Rate	0.57	0.57	0.57
Expense	$3.0951	$1.1913	$0.0385
Facilities			0.0092
Ground Property and Equipment			
Maintenance			0.0002
Depreciation			0.0002
Reservation and Sales and			
Advertising and Publicity			0.0094
General and Administrative	0.1597	0.0615	0.0030
Total Expense	$3.2548	$1.2528	$0.00605
Return and Taxes	0.4723	0.1818	0.0088
Total Noncapacity Cost	$3.7271	$1.4346	$6.93/Cwt

TABLE 1-53

COST-BASED RATES - 1974

MULTIELEMENT RATE FARE STRUCTURE

	Capacity Line-Haul Costs/Lb-Mi.	Terminal Charge			
		Noncapacity		Per CWT	
		Per Shipment	Per Piece	Capacity Portion	Noncapacity Portion
GENERAL BULK	0.007¢	$3.73	$1.43	$5.38	$6.93

with type of equipment utilized and the capacity of the aircraft may affect the line-haul costs per ton mile. In addition, these costs are not applicable to international operations because of cost differentials in fuel, labor, landing and handling fees, taxes, etc.

Nevertheless, considering the above limitations, comparisons can be made on the effects of distance, commodity types, bypass containerization, and densities. Using Tables 1-49 and 1-54, some of the major cost elements can be separated to show the cost impact of distance, commodities, and containerization on airfreight shipments.

Cost element analysis. - For a comparison of subelement charges, again assume a general commodity shipment of 2000 lb, 44 pieces from LAX to NYC (2144 statute miles). (See Table 1-49.)

Step 1 Maximum Fare = (S + (P * N)) + (C * W * M) + W * (F + R)

Terminal Noncapacity Cost/Shipment (S) = 3.79

Terminal Noncapacity Cost/Piece (P) = 1.46

Number of Pieces N = 44

.˙. (3.79 + (1.46 x 44) = $68.03 (Terminal Labor-Related Charge)

Step 2 Capacity Line-haul Cost/Lb Mile (C) = 0.00849

Weight of Shipment (CWT) (W) = 20

Mileage (M) = 2144

.˙. (0.00849 * 20 * 2144) = $364.05 (Capacity Line-Haul Charge)

Step 3 Capacity Terminal Portion/CWT (F) = 6.67

Noncapacity Terminal Portion/CWT (R) = 6.76

.˙. (20 * (6.67 + 6.76) = $268.60 (Terminal Charge/CWT)

or (20 * 6.67) + (20 * 6.76) = $133.40 + 135.20 or 268.60

As a result of the previous calculation, assuming a 2000-lb shipment of 44 pieces from LAX-NYC (2144 statute miles), the general bulk fare element breakdown is as follows:

	$	%
Capacity Line Haul	364.05	52
Noncapacity Terminal Handling	68.03	10
Capacity Terminal - CWT	133.40	19
Noncapacity Terminal - CWT	135.20	19
	700.68	100

Note: Includes tax and return markup.

TABLE 1-54

REGULAR BULK FREIGHT FARES
BY STAGE LENGTH
(2000 LB, 44 PIECES)

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Mileage	Maximum Rate $	Terminal Noncapacity (Minimum Rate) $	Percent	$/RTM
100	353.61	336.63	95	3.54
200	370.59	336.63	91	1.85
300	387.57	336.63	87	1.29
400	404.55	336.63	83	1.01
500	421.53	336.63	80	0.84
750	463.98	336.63	72	0.62
1000	506.48	336.63	66	0.51
1500	591.33	336.63	57	0.39
2000	676.23	336.63	50	0.34
2500	761.13	336.63	44	0.30
3000	846.03	336.63	40	0.28
4000	1015.83	336.63	33	0.25
5000	1185.63	336.63	28	0.24

Bypass containers: Assume the shipper utilizes an LD-3 type bypass container. The tare weight of an LD-3 is 200 lbs. The external size of the container is 166 cu ft, and the dockside density is 12 lb/cu ft. The carrier can charge the net weight (2000 lb) plus the tare weight of the container (200 lb) for rate calculations (2200 lb). The multielement rate formula treats the container as one piece, as opposed to numbers of pieces in general bulk shipment, since the container is shipper loaded and unloaded as one unit. Also, since the container is delivered ready for shipment, a smaller allocation is provided for noncapacity costs/CWT. The shipment is from LAX to NYC. The rate for a bypass LD-3 containing 2000 lb is calculated as follows:

Step 1 Maximum Fare = (S + (P * N)) + (C * W * M) + W * (F + R)

Terminal Noncapacity Cost/Shipment (S) = 3.79

Terminal Noncapacity Cost/Piece (P) = 43.66

Number of Pieces (N) = 1

∴ 3.79 + (43.66 * 1) = 47.45 (Terminal Labor-Related Charges)

Step 2 Capacity Line-Haul Cost/Lb Mile (C) = 0.00849
Weight of Shipment/CWT (W) = 22
Mileage (M) = 2144
.'. (0.00849 * 22 * 2144) = 400.46 (Capacity Line-Haul Charge)

Step 3 Capacity Terminal Charge/CWT (F) = 6.67
Noncapacity Terminal Charge/CWT (R) = 2.29
Weight of Shipment/CWT (W) = 22
(22 * (6.67 + 2.29) = 197.12 (Terminal Charge-CWT)

	Bypass	Regular Bulk	
Capacity Line Haul	400.46	364.05	
Noncapacity Terminal Handling	47.45	68.03	
Capacity Terminal/CWT	146.74	133.40	
Noncapacity Terminal/CWT	50.38	135.20	
	645.03	700.68	Δ = 7.9%

A comparison of a shipper-loaded LD-3 container containing 2000 lb (LAX-NYC) versus 2000 lb of regular bulk freight delivered to the carrier is illustrated above. As shown, the cost savings (assuming no discount) is approximately 8 percent. The reason for the difference in capacity costs is the additional charge for the tare weight of the container, which is additive in the case of bypass containers.

It is misleading to assume that the cost of air shipments is reduced by shipper-loaded containers. The costs of loading, unloading, sorting, etc., are incurred whether it be conducted by the carrier or the forwarder, plus forwarder service charges and markup. The cost differential, therefore, could be broadly interpreted as the cost of service.

The cube rule. - Theoretically, stowed density should equal the design density of the aircraft. In reality, airfreight shipments vary considerably. The multielement rate structure translates volume into weight. In practice, the capacity of the aircraft is seldom filled by weight, and the aircraft usually "bulk out" rather than "weight out." The CAB therefore established a cube rule wherein commodities falling below the density of 8.9 lb/cu ft could be assessed. For example, floral products that may have a density of 4 lb/cu ft can be articially increased to 8.9 lb/cu ft for rate-making purposes. The cube rule applies to dockside density in bulk shipments.

Many aspects of the CAB rate fare structure have been omitted in this discussion. For example, charges for carrier-unloaded bypass containers, customer service fees, interline rates, etc. The purpose of this discussion was to examine the CAB's methodology in determing cost-causative elements of airfreight shipment and to utilize applicable features of this methodology to cost analysis.

The major achievement in the DAFRI investigations was the definition of noncapacity terminal costs. No matter how the carrier wishes to calculate his costs he cannot exceed the maximum rates established in the DAFRI decision.

As noted, capacity line-haul costs (aircraft related) represent the most significant portion of operating costs. Additionally, aircraft price-related costs (investment costs) represent a large expense item that must also be considered in aircraft equipment selection.

Cost sensitivities. - The U.S. certificated carriers are required by law to submit financial and operational data to the CAB on a regular basis. These data include operational statistics by aircraft type as well as by segment. These data are published by the CAB and provide the most reliable data base from which cost sensitivities can be made.

As shown in Table 1-55 of reported CAB data, the bulk of the revenues for total domestic cargo services is in freight (88 percent), and line-haul costs represent over 50 percent of operating costs.

The distribution of operating costs have varied over the years due to changes in aircraft mix, and varying escalation rates for major cost contributors such as fuel, labor, materials, and capital costs as shown in Tables 1-56 and 1-57 (Reference 1-20 and 1-14 respectively).

TABLE 1-55

DOMESTIC SCHEDULED AIR CARGO SERVICES
12 MONTHS ENDED DECEMBER 31, 1976
TOTAL DOMESTIC OPERATIONS

	Total Domestic ($000)	%	Pax/Cargo ($000)	%	All Cargo ($000)	%
Revenue						
U.S. Mail	22 290	6	20 215	8	2 075	2
Express	19 017	6	1 261	1	17 756	17
Freight	302 245	88	217 094	90	85 151	81
Miscellaneous	447	-	-	-	447	-
Total Transport Revenue	343 999		238 470		105 429	
Incidental Revenue	1 270	-	1,375	1	(105)	-
Total Operating Revenue	345 269		239 945		105 324	
Flying Operations	132 448	38	87 413	37	45 035	42
Maintenance	46 761	14	33 544	14	13 217	12
Aircraft Servicing	24 782	7	18 269	8	6 513	7
Traffic Servicing	74 109	21	50 423	21	23 686	22
Reservations and Sales	11 523	3	7 934	3	3 589	3
Advertising and Publicity	3 550	2	2 570	1	980	1
General and Administrative	18 739	5	12 084	5	6 655	6
Depreciation and Amortization	33 549	10	26 746	11	6 803	6
Total Operating Expenses	345 461		238 983		106 478	
Operating Profit (Loss)	(192)		962		(1 154)[1]	

[1] Airlift loss was $1653 during this year.

TABLE 1-56

PERCENTAGE DISTRIBUTION OF TOTAL OPERATING EXPENSES
ALL-CARGO SERVICE

Year	66	67	68	69	70	71	72	73	74	75	76 (EST)
Flying Operations	30.4	31.8	32.1	32.3	31.6	31.8	31.1	32.6	39.3	40.2	39
Maintenance A/C	16.9	15.0	14.8	14.4	13.6	12.2	12.6	13.2	12.1	11.7	13
Depreciation A/C	9.6	10.7	11.9	10.8	10.6	9.9	9.2	8.5	7.5	7.2	8
Total	56.9	57.5	58.7	57.6	55.9	53.9	53.0	54.3	59.0	59.1	60
A/C Servicing	9.0	9.1	9.3	8.8	9.5	9.9	9.9	9.6	8.2	8.3	8
Traffic Servicing	19.6	19.2	17.7	18.5	20.2	20.8	20.8	20.5	18.0	18.5	19
Reservations and Sales	5.0	4.9	4.9	5.7	5.3	5.7	6.3	6.0	5.7	5.5	5
Advertising and Publicity	2.3	2.3	2.0	2.0	1.5	1.5	1.5	1.3	1.0	1.0	1
G and A	4.8	4.7	4.8	4.7	4.9	5.4	5.7	5.8	5.8	5.4	5
Ground Equipment Maintenance and Depreciation	2.2	2.5	2.6	2.7	2.7	2.9	2.9	2.6	2.4	2.3	2
Total	43.1	42.5	41.3	42.4	44.1	46.1	47.0	45.7	41.0	41.0	40

Note: Columns do not necessarily add due to rounding.

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TABLE 1-57

PERCENT INCREASE IN FREIGHTER CAPACITY EXPENSE

	CY 1972			Year Ended Sept. 30 1976			Unit Cost Increase (%)
	Cost ($000)	RTM's (000)	Unit Cost (¢)	Cost ($000)	RTM's (000)	Unit Cost (¢)	
Fuel	39 110	-	2.65	71 743	-	5.6	111.3
Depreciation	17 712	-	1.88	28 202	-	2.2	17.0
Other	90 966	-	6.15	98 389	-	7.68	24.9
G and A	7 694	-	0.52	9 787	-	0.76	46.2
Total	165 493	1 478 170	11.20	208 121	1 281 511	16.24	45.0

As shown in the multielement rate structure analysis, changes in stage length will also affect the distribution of costs. The previous tables represent costs of a composite of carriers and aircraft types over an average stage length.

The impact of fuel prices on flying operations by aircraft type is illustrated by examining aircraft operating expenses by aircraft type. (See Tables 1-58 and 1-59, Reference 1-21.)

Aircraft shown are reported as cargo/cabin configuration; therefore crew costs may be overstated. More importantly, the above aircraft types are representative of all-cargo domestic operations. Stage lengths vary with the type of aircraft used,and each aircraft has a different capacity. For example, the average stage length for the 727-100QC was 915 statute miles in 1976. The DC-8 and B707 averaged 1150 miles during the same time period. Average available tons per aircraft mile were as follows: B727 = 18.5 tons, DC-8 = 38.1 tons, B707 = 36.4 tons. International operations provide a wider selection of aircraft types as well as different cost distribution.

It should be noted that international fuel rates are approximately 25 percent more than U.S. domestic rates.

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TABLE 1-58

DOMESTIC TRUNKS CARGO OPERATIONS
BY SELECTED AIRCRAFT TYPE
1976

Cost Element	Aircraft Type					
	B727-100QC		DC-8-50F		B707-300C	
	$/BH	%	$/BH	%	$/BH	%
Flying Operations (Less Rentals)						
Crew	247.50	38	347.87	40	338.02	40
Fuel and Oil	406.21	62	588.51	60	507.68	59
Insurance	4.68	-	1.59	-	6.77	1
Other	0.11	-	0.06	-	0.87	-
Total	658.50	100	938.03	100	853.34	100

TABLE 1-59

INTERNATIONAL/TERRITORIAL ALL-CARGO OPERATIONS
BY SELECTED AIRCRAFT TYPE
1976

Cost Element	Aircraft Type							
	B747		B747F		DC-8-61		DC-8-63F	
	$/BH	%	$/BH	%	$/BH	%	$/BH	%
Flying Operations (Less Rentals)								
Crew	529.01	27	401.20	20	321.75	28	408.38	34
Fuel and Oil	1376.52	71	1524.35	76	808.95	70	783.73	64
Insurance	41.14	2	86.25	4	30.84	2	23.39	2
Other	-	-	-	-	-	-	-	-
Total	1946.67	100	2011.80	100	1161.54	100	1215.50	100

It is fortuitous for the airfreight industry that capacities of the new wide-bodied equipment have increased more than operating costs, thus tending to reduce the effect of cost increases. This is illustrated in Figure 1-32 (Reference 1-21). It is equally obvious that the application of large wide-bodied aircraft will not be as effective in the shorter stage lengths due to less efficient utilization of block fuel burned and maintenance. More importantly, since terminal costs are largely capacity related, one would expect higher fixed costs which would further penalize large wide-bodied aircraft in short haul segments.

Figures 1-33 and 1-34 (Reference 1-20) illustrate the increased utilization of wide-body aircraft and the net effect of these aircraft on costs per available ton-mile. As shown in Figure 1-35, the all-cargo carriers still have a way to go in order to achieve a 12-percent return on investment.

Investment-related factors: As yet, little attention has been given in this report to investment-related costs in the air cargo industry. The airfreight industry is considered to be capital intensive. This is traditionally measured by the investment turnover ratio, that is, the time it takes the revenue of the company to equal the investment. Table 1-60 illustrates the invested capital for the domestic all-cargo carriers year ending December 1976. Noting from Table 1-55, the revenue for the same group of carriers was $343,999,000. The turnover ratio is, therefore, 1:2 (revenue ÷ invested capital). More labor-intensive industries, such as trucking, freight forwarders, and retail establishments, will have much higher investment turnover ratios.

Assuming a 1-1 debt-to-equity ratio and an 8-percent cost of debt, one can examine the capital costs and the relationship of these costs to the total cost of airfreight shipment. This illustration excludes tax benefits from interest deduction, investment tax credit provisions, and tax loss carryovers, etc.

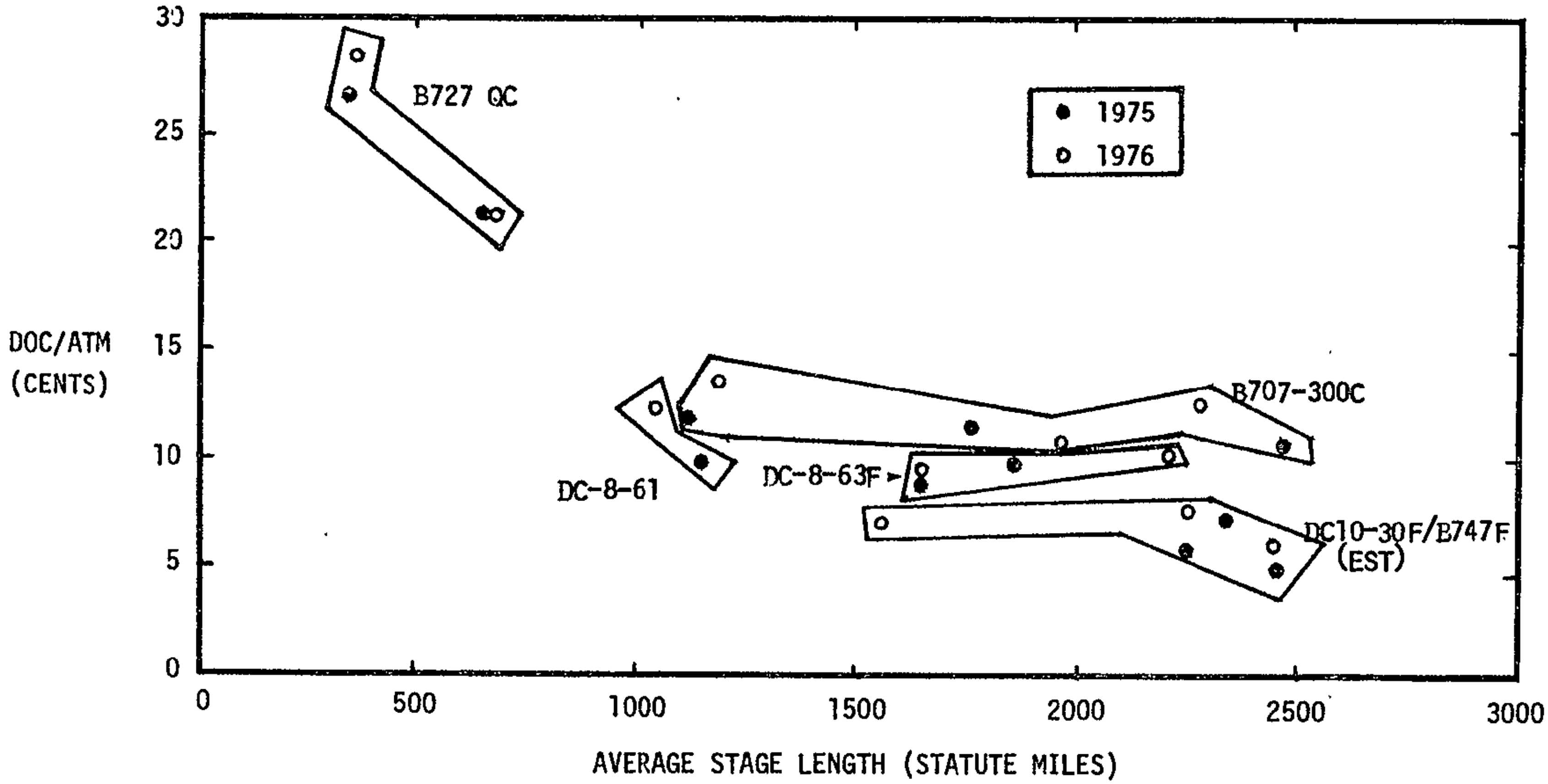

Figure 1-32. Direct Operating Expenses by Available Ton-Mile by Aircraft Type All-Cargo Services (International) 1975-1976

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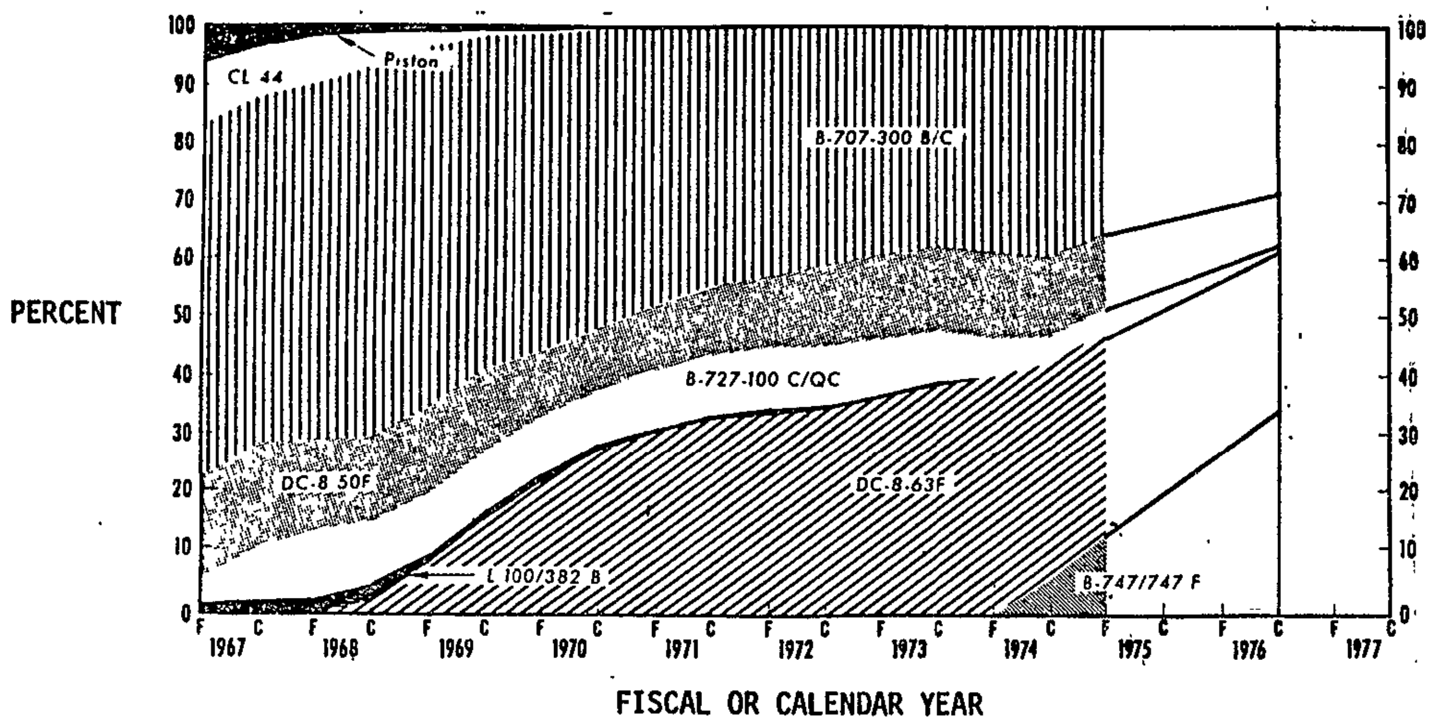

Figure 1-33. Percentage Distribution of Traffic Flown (Revenue Ton-Miles) by Aircraft Type
Scheduled All-Cargo Service, Total Certificated Industry

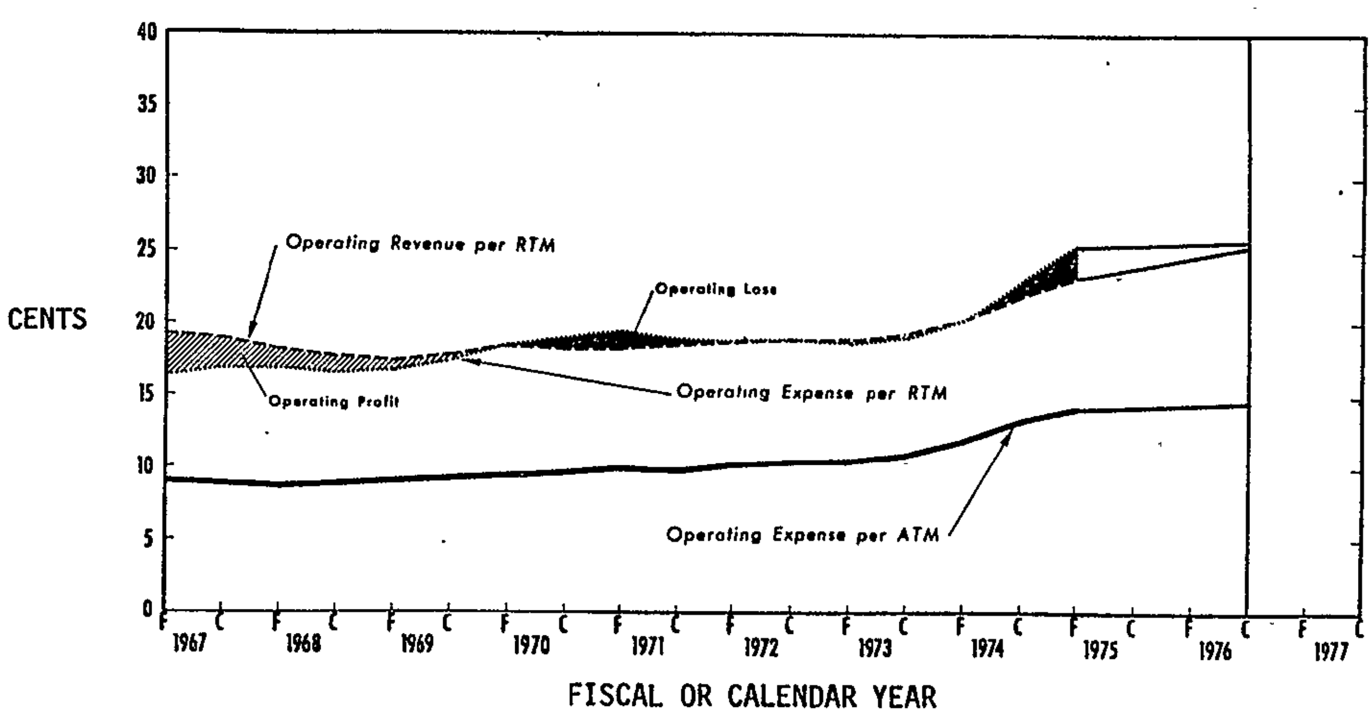

Figure 1-34. Financial and Operational Trends
Scheduled All-Cargo Service, Total Certificated Industry

TABLE 1-60

INVESTED CAPITAL
DOMESTIC SCHEDULED ALL CARGO SERVICE
SELECTED CERTIFICATED ROUTE AIR CARRIERS,
DECEMBER 31, 1976

	Total Domestic ($000)	Pax/Cargo ($000)	All Cargo ($000)
Working Capital	37 728	19 301	18 427
Fixed Capital (Net)			
Flight Equipment	215 001	169 091	45 910
Ground Property and Equipment	31 034	18 679	12 355
Total	246 035	187 770	58 265
Investments and Special Funds	1 082	1 082	-
Long-Term Prepayments	970	688	282
Deviation and Preoperating Costs	1 006	113	893
Unamortized Discount and Expense on Debt	988	179	809
Other	55	47	8
Total	287 864	209 180	78 684

As shown in Table 1-61, the investment-related costs are estimated to be 14 percent for the airfreight industry in 1976. As the airfreight industry expands and new and more efficient equipment is purchased, these investment-related costs may become more significant. (Reference 1-22).

TABLE 1-61

OPERATING COST ELEMENTS, SCHEDULED ALL-CARGO SERVICES, DECEMBER 31, 1976

By Function	Percent	By Relationship	Percent
Flying Operations	37	Flight Related	49
Aircraft Maintenance	13	Payload Related	33
Aircraft Depreciation	8	Investment Related	13
Total	58	Management Related	5
Aircraft Servicing	7	Total	100
Traffic Servicing	21		
Reservations and Sales	3		
Advertisement and Publicity	1		
Ground Equipment Maintenance and Depreciation	2		
General and Administration	5		
Total	39		
Interest (Estimated)	3		
Net Operating Costs Before Taxes	100		

U.S. International and Foreign Routes

The objective of this analysis is to characterize the U.S. international and foreign airfreight markets as they exist today. These markets can best be described with respect to total trade growth and the factors leading to development of airfreight services. The data and information presented have been grouped into the following five categories:

- Data Base of External Trade U.S., UN.
- U.S. International Commodity Networks.
- U.S. International Airfreight Markets.
- Foreign Commodity Networks.
- Foreign Airfreight Markets.

A data base was assembled which includes the latest foreign trade for both U.S. and other major trading countries of the world. This data set provided the framework for the initial selection of commodity networks, and secondly, a selection of airfreight markets from within the broader commodity networks. This data base provides the foundation from which all subsequent analyses will emanate.

Data base of external trade U.S., UN. - A proficient analysis of airfreight markets depends to a large degree on the availability of adequate trade data. Douglas computerized data banks include annual trade statistics from the U.S. Department of Commerce and the United Nations. The Commerce data are being used in conjunction with analysis of U.S. markets, and the United Nations data are utilized to examine foreign channels of trade. Figure 1-35 shows the basic data flow for U.S., UN external trade.

U.S. 1976 export/import traffic: This data base reflects the total physical movement of merchandise between 43 U.S. customs districts and more than 200 foreign countries based upon the U.S. Department of Commerce Export/Import Statistics (Reference 1-23). With the flexibility of large computers, it is possible to array data in a variety of usable forms. The total 1976 exports and imports are summarized by custom's district traffic for air and sea modes. These tabular listings provide a valid and accurate profile of current tonnage and dollar flows through all U.S. gateways. It has been

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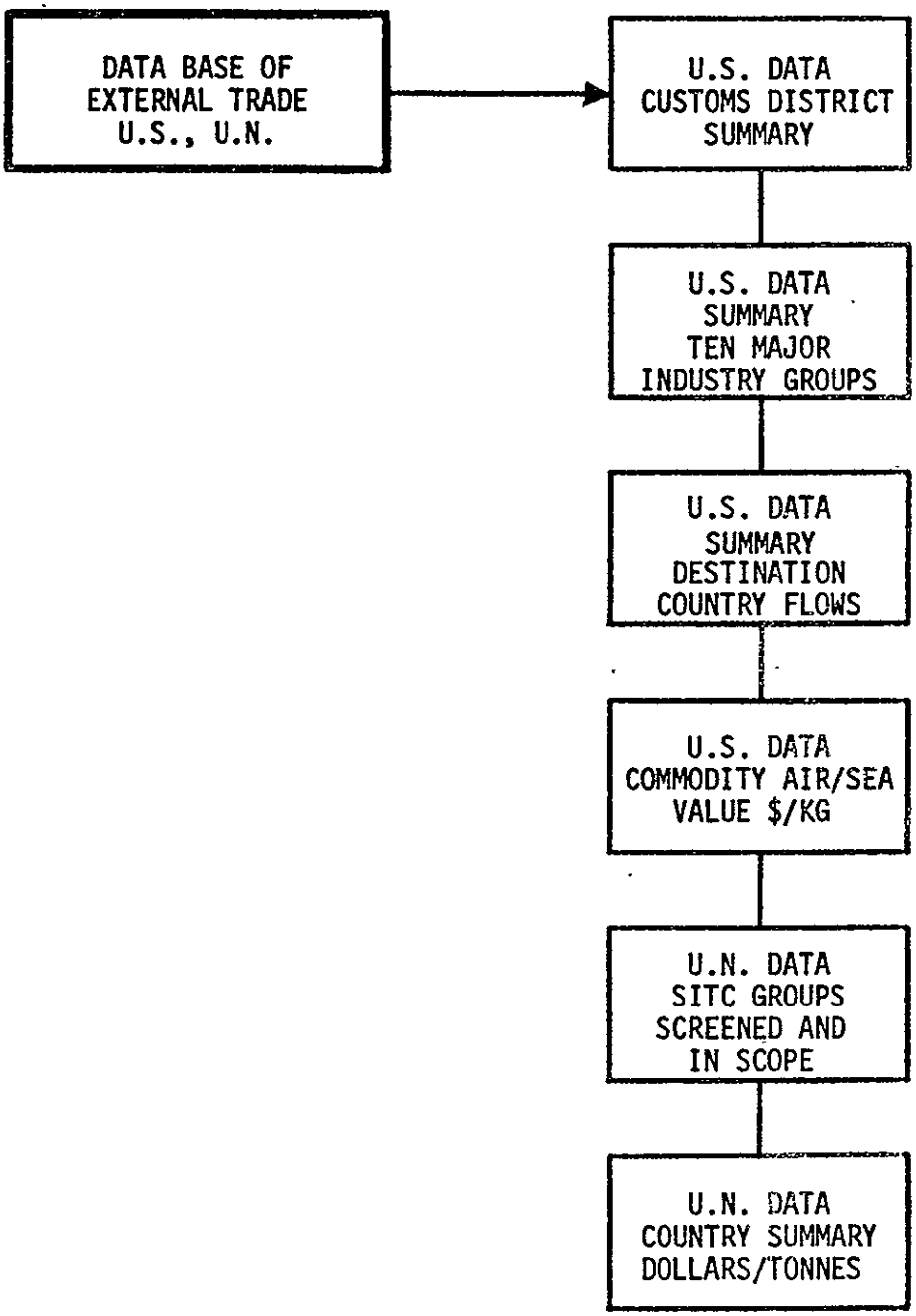

Figure 1-35. Basic Data Flow for External Trade

determined from these tables that only a half-dozen air gateways generate more than 80 percent of total airfreight traffic. The total U.S. multi-directional air flow for 1976 of nearly 1.25 million air tonnes represented a 9-percent growth over year 1975. The pattern for sea traffic is somewhat different. Roughly 15 seaports generate in excess of 85 percent of the external deep-water trade.

A summary of trade has been arrayed into 10 basic Standard Industrial Trade Classification (SITC) commodity groups (Reference 1-24). Data for analysis include air dollars and air tonnes, sea dollars and sea tonnes, and dollar value only for trade by other transport modes; these include truck, barge, and rail traffic to the countries contiguous with the U.S. Exports and imports are arrayed side by side to allow a cross comparison by direction of flow. Various magnitudes of trade among various commodity groups can be rapidly ascertained. Another output contains individual trade between U.S. and more than 170 country trading partners. Exports and imports are arrayed side by side to facilitate comparative analysis. This country-by-country matrix provides a convenient detailed reference of external trade generated by specific countries or regions.

The U.S. foreign trade data generally provide an extensive volume of detail. One of the most useful and relevant sets of information is that of product value. Any evaluation of transportation flows will eventually involve product value, particularly an analysis of air potential. A special program is available to process value separately and output average values for more than 1300 detail SITC product descriptions. Values for sea and air are computed separately to provide modal comparison.

Another partition of the data files includes an average density for each five-digit SITC commodity group. The density data were developed through intensive on-going Douglas studies from a variety of sources. These include some 14 different commodity density studies by the U.S. trucking and rail industries and various airline studies. These data are used in conjunction with both U.S. and U.N. trade data analyses. They are stored in computer data arrays and accessed as required by operating programs.

United Nations 1975 trade data: Douglas purchases United Nations annual trade data (Reference 1-25) for approximately 40 countries as it becomes available from the New York computer center. These data are processed and stored on magnetic tape to make them available for analysis of freight markets. The U.N. data, unlike its U.S. counterpart, has only total tonnes and dollar flow for all modes; no air data have been assembled by individual country. These basic data provide the necessary vehicle for analysis and study of world freight flows and patterns. Table 1-62 is a list of those reporting countries for which data were purchased. Shown also in this table is the dollar value of exports generated by each International Monetary Fund (IMF) input. When USA is added to the list to make an even 40 countries, this set of countries combined generates more than 80 percent of the world's international trade. It should be noted here, in contrast to the U.S. foreign trade data, that commodity groups for oil, raw materials, and other bulk items are not included in the data base. See Table 1-63 for two-digit SITC groups comprising the data base and Table 1-64 for the list of excluded bulk and low-value commodity groups.

U.S. international commodity networks. - This study affords an opportunity to identify some of the more important factors affecting the increasing competition between air and surface transport modes. This contrast can best be shown by clearly understanding the primary trade flows as they exist today (see Figure 1-36), and the potential growth patterns of the air mode within this intensive international trade environment. There is little doubt that rate of progress of the airfreight industry correlates closely with the state of the world economy. At the same time, it depends directly on the strategy employed by governments and industry to sustain a longer-term growth.

To assist the analysis of U.S. international commerce, the U.S. Department of Commerce foreign trade data are consulted and used as a frame of reference. Tables 1-65 and 1-66 tabulate the U.S. export/import trade with six major world regional sectors. More than 40 percent of U.S. dollar exports flow to the Western Bloc of European countries while over 30 percent moves to the Asian area. The rest of the world trade comprises more than a quarter of the total trade but includes many emerging Third World nations. Table 1-66 shows that the regional mix of imports flowing back to the U.S. is somewhat

TABLE 1-62

MAJOR UNITED NATIONS COUNTRIES

(EXPORTS TO WORLD)

Country	1975 IMF Dollar Flow $\$ 10^9$	Country	1975 IMF Dollar Flow $\$ 10^9$
Afghanistan	0.3	Korea	6.1
Argentina	3.5	Kuwait	2.3
Australia	9.4	Mexico	7.8
Belgium LUX	30.0	Morocco	2.4
Brazil	11.6	Netherlands	38.2
Canada	32.4	New Zealand	3.0
Chile	1.7	Nigeria	5.2
Colombia	1.5	Pakistan	2.1
Czechoslovakia	2.8	Singapore	8.0
Denmark	9.5	Spain	14.8
Egypt	4.0	Sweden	16.3
France	50.1	Switzerland	15.2
Ghana	0.8	Turkey	4.7
Hong Kong	6.7	U.K.	48.2
Hungary	2.3	Venezuela	5.0
India	5.8	West Germany	70.0
Indonesia	5.0	Yugoslavia	7.6
Iran	13.1	Subtotal	535.5
Italy	35.5	U.S.	100.0
Ivory Coast	1.1	Total	635.5
Japan	50.5	(= 81% of Total World Trade)	
Kenya	0.9		

TABLE 1-63

SELECTED SITC TRADE GROUPS

SITC Code	Description	SITC Code	Description
00	Live Animals	62	Articles of Rubber, NES
01	Meat and Meat Preparation	63	Wood Manufacturers, NES
02	Dairy Products and Eggs	64	Paper Manufacturers
03	Fish and Fish Preparation	65	Textile Yarn and Fabrics
05	Fruits, Vegetables, Nuts	66	Glassware, China, Precious Stones
06	Confectionary Products	67	Iron and Steel
07	Coffee, Tea, Cocoa, Spices	68	Nonferrous Metals
09	Miscellaneous Food Preparation	69	Manufacturers of Metal
11	Beverages	71	Machinery, other than Electrical
12	Tobacco Manufacturers	72	Electrical Machinery
21	Hides and Fur Skins	73	Transport Equipment
29	Live Plants and Cut Flowers	81	Sanitary, Plumbing, Heating
51	Chemical Elements	82	Furniture
53	Dying, Tanning, Coloring Materials	83	Travel Goods, Handbags
54	Medicinal and Pharmaceutical	84	Clothing
55	Essential Oils, Perfume	85	Footwear
58	Plastic Materials, Resins	86	Professional, Scientific Products
59	Chemical Materials	89	Miscellaneous Manufacturers
61	Leather, Leather Manufacturers		

TABLE 1-64

SCREENED SITC TRADE GROUPS

SITC Code	Description
04	Wheat and Rice Products
08	Feeding Stuff for Animals
22	Oil Seeds and Oil Nuts, etc.
23	Crude Rubber Including Synthetic
24	Wood, Lumber and Cork
25	Pulp and Waste Paper
26	Textile Fibres and Waste
27	Crude Fertilizers and Minerals
28	Metal Ores and Metal Scrap
32	Coal, Coke and Briquettes
33	Petroleum and Products
34	Gas, Natural and Manufactured
41	Animal Oils and Fats
42	Fixed Vegetable Oils and Fats
43	Processed Oils, Fats, and Waxes
52	Mineral Tar and Crude Chemicals
56	Fertilizers Manufactured
57	Explosives and Pyrotechnic Products

different. Here the Asian countries comprise over 40 percent of the market and the European Bloc accounts for less than 25 percent of total trade. Japan is particularly dominant in this market with its intense capability to provide a wide range of consumer products.

Since it was not feasible to analyze all of the approximate 400 trade flows between U.S. and partner countries, a preliminary set of 50 countries was initially selected. From this group, 16 of the important trading partner countries were finally selected in analysis. This set of countries is listed in Table 1-67. A major criterion in the selection process was the IMF dollar

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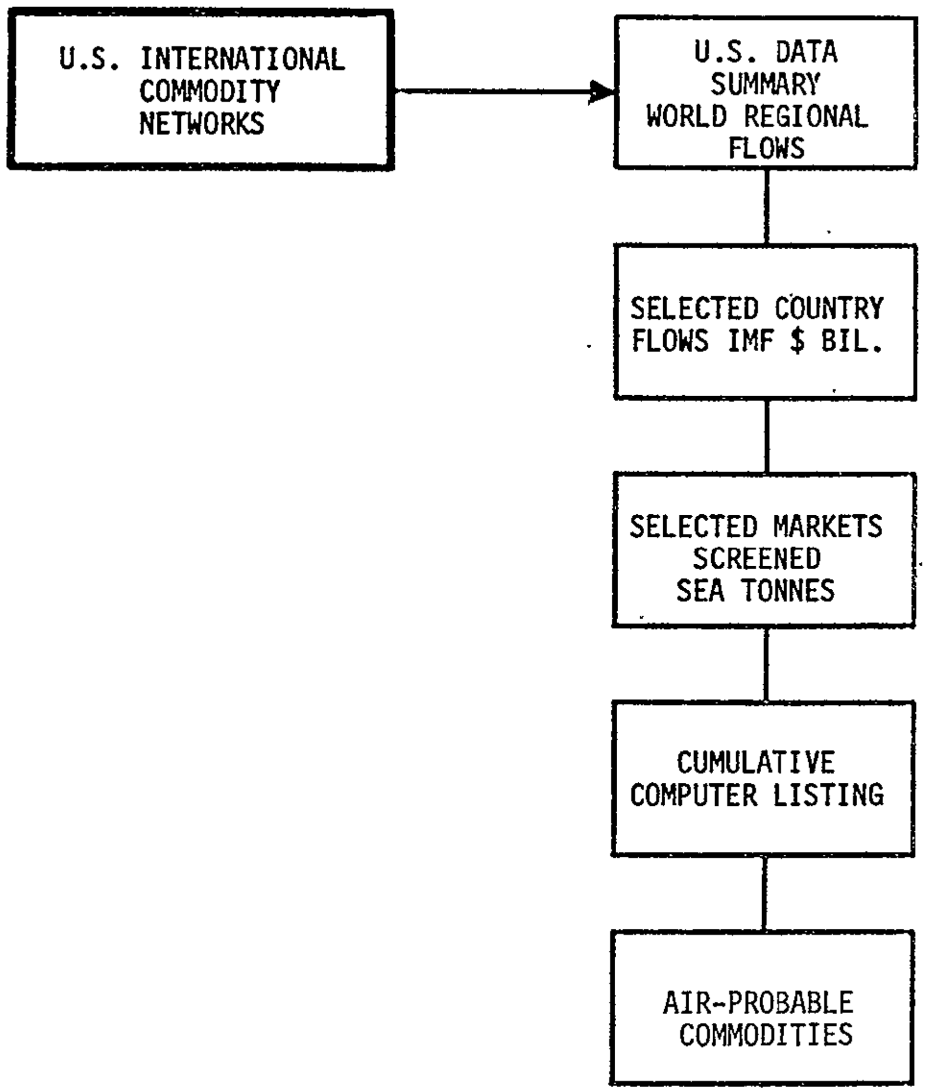

Figure 1-36. U.S. International Commodity Networks Data Flow

TABLE 1-65

REGIONAL FLOWS

U.S. EXPORTS 1976

Regions	Vessel		Air	
	$	Tonnes	$	Tonnes
North America	4 085 150 860	33 541 596	1 756 874 507	146 454
South America	6 859 718 979	16 684 135	1 231 696 288	85 702
Europe	25 399 414 709	104 019 050	7 705 685 366	260 689
Asia	21 782 316 445	88 524 837	4 567 805 775	128 874
Australia/Oceania	2 043 642 328	2 494 000	494 116 579	16 511
Africa	3 917 383 663	8 312 984	566 780 314	20 557
Unidentified Countries	385 051 939	2 913 033	Ø	Ø
TOTAL	64 482 678 923	256 489 635	16 322 958 829	658 787
Percent Tonnes		99.7		0.3
Percent $	79.8		20.2	

TABLE 1-66

REGIONAL FLOWS

U.S. IMPORTS 1976

Regions	Vessel		Air	
	$	Tonnes	$	Tonnes
North America	7 900 555 265	106 447 455	836 301 791	67 558
South America	7 269 076 065	70 409 316	464 790 172	51 618
Europe	17 577 289 159	27 928 636	4 760 075 067	209 621
Asia	34 465 756 062	145 759 202	4 351 587 869	213 870
Australia/Oceania	1 575 597 023	5 531 179	76 831 123	4 087
Africa	11 969 942 027	113 322 850	356 454 061	2 613
Unidentified Countries	476 000	729	982 300	365
TOTAL	80 758 691 601	469 399 367	10 847 022 383	549 732
Percent $	88.2		11.8	
Percent Tonnes		99.9		0.1

TABLE 1-67

U.S. INTERNATIONAL COMMODITY FLOWS

IMF TRADE 1975

Country	Export $ Bil	Import $ Bil	Country	Export $ 10^9	Import $ Bil
UK	4.5	4.1	Iran	3.3	1.6
Japan	9.6	12.3	Brazil	3.1	1.6
France	3.1	2.3	Taiwan	1.7	2.2
West Germany	5.2	5.8	Hong Kong	0.9	1.8
Italy	2.9	2.7	Indonesia	0.8	2.4
Australia	1.8	1.3	Nigeria	0.6	3.5
South Africa	1.3	0.9	Bolivia	0.2	0.1
Venezuela	2.2	3.6	Morocco	0.2	0.1

volume of external trade generated with the United States. Values for both exports and imports are indicated by respective country for year 1975. These 16 U.S. trading partners also have other important economic and political ties with the U.S.. For example, Indonesia is rapidly becoming an important U.S. trading partner. This is occurring because of the energy supplies that exist there and, by the 1980s, per capita income will have risen significantly so that increasing imports from U.S. can be financed. Also Indonesia is located critically in the world geography. Bolivia is another example of an important developing country. Located as it is in South America and the Western hemisphere, it is important politically, and being landlocked is equally important from the standpoint of air development. The overriding consideration of energy availability and political strategy could well make a number of countries more significant as U.S. trading partners during the next decade.

The total 1976 export and import trade flows for each of the 16 partner countries has been tabulated in Tables 1-68 and 1-69. Tonnage and dollar figures for air, screened and total, have been listed. Air flow and total sea flow are self-explanatory. The screened volumes were derived by excluding

TABLE 1-68

SELECTED U.S. INTERNATIONAL COMMODITY NETWORKS - 1976 EXPORTS

U.S. to:	Air ($ M)	Tonnes Air	Screened Sea ($ M)	Screened Sea Tonnes	Total Sea ($ M)	Total Sea Tonnes	Air % Screened Tonnes	Air % Total Tonnes
1. Bolivia	31.9	2 490	95.6	77 996	99.3	85 007	3.2	2.8
2. Brazil	405.0	15 933	1 737.8	1 712 367	2 330.0	8 278 978	1.0	0.0
3. U.K.	1 660.3	59 726	2 157.0	1 537 984	2 864.6	5 987 431	3.9	1.0
4. France	1 268.5	45 552	1 385.4	914 647	1 992.0	7 060 244	5.0	0.7
5. W. Germany	1 593.3	48 175	1 901.5	1 210 851	3 823.7	14 439 145	4.0	0.3
6. Italy	643.3	18 943	850.4	661 500	2 208.6	12 047 591	2.9	0.2
7. Iran	631.0	16 894	1 177.2	461 238	1 415.7	1 907 202	3.7	0.9
8. Indonesia	77.3	1 609	614.3	267 056	842.0	1 183 950	0.6	0.02
9. Hong Kong	335.5	6 672	527.6	579 680	618.5	764 094	1.2	0.8
10. Taiwan	267.7	5 773	796.8	490 428	1 293.5	3 165 115	1.2	0.2
11. Japan	1 399.7	36 970	3 011.7	2 228 612	8 508.1	61 286 420	1.7	0.1
12. Australia	412.7	12 764	1 508.8	728 964	1 676.1	1 802 054	1.8	0.7
13. Nigeria	119.0	4 088	455.1	242 273	575.5	919 546	1.7	0.5
14. S. Africa	210.4	5 728	835.6	445 670	915.3	869 847	1.3	0.7
15. Venezuela	438.0	40 172	1 747.5	1 160 683	2 054.1	3 013 349		1.3
16. Morocco	23.3	547	81.0	25 477	182.3	645 081		0.1
	9 516.9	322 036	16 726.3	12 745 426	31 399.3	123 455 054	2.5	0.3

TABLE 1-69

SELECTED U.S. INTERNATIONAL TRADE NETWORKS - 1976 IMPORTS

U.S. from:	Air ($ 10^6)	Tonnes Air	Screened Sea ($ 10^6)	Screened Sea Tonnes	Total Sea ($ 10^6)	Total Sea Tonnes	Air % Screened Tonnes	Air % Total Tonnes
1. Bolivia	4.2	429	34.0	41 227	108.8	292 070	1.0	0.2
2. Brazil	155.3	13 291	1 391.0	1 205 017	1 576.6	7 170 771	1.0	0.2
3. U.K.	1 090.0	41 522	2 625.5	1 822 364	2 793.1	3 480 010	2.3	1.2
4. France	636.4	23 644	1 690.5	1 715 686	1 750.2	2 394 509	1.4	1.0
5. W. Germany	805.3	41 548	4 507.3	2 191 454	4 635.7	3 250 372	1.9	1.3
6. Italy	693.8	36 495	1 588.0	1 298 492	1 802.7	3 751 787	2.8	1.0
7. Iran	18.1	524	98.0	65 404	1 461.4	15 463 128	0.8	-
8. Indonesia	9.8	527	210.6	129 034	2 979.2	27 275 813	0.5	-
9. Hong Kong	743.4	45 827	1 567.6	434 400	1 571.3	441 116	10.5	9.4
10. Taiwan	418.3	28 086	2 546.6	1 499 500	2 557.7	1 533 086	1.9	1.8
11. Japan	1 622.0	80 098	13 758.5	12 178 067	13 809.8	12 416 474	0.7	0.7
12. Australia	58.6	2 292	689.8	888 000	1 138.2	5 165 912	0.3	0.04
13. Nigeria	1.6	106	66.7	52 376	4 936.0	50 339 218	0.2	-
14. S. Africa	270.7	534	200.1	315 200	362.5	2 228 585	0.2	-
15. Venezuela	40.6	7 174	316.9	55 191	3 521.9	52 126 980	13.0	-
16. Morocco	4.7	316	4.3	3 535	11.5	134 809	8.9	0.2
	6 572.8	322 463	31 295.4	23 894 947	45 016.6	187 464 640	1.3	0.2

all low-value bulk commodities such as steel scrap, petroleum products, lumber, wheat, etc. Screened sea tonnes or "liner traffic" comprise only 10 percent of total sea tonnes; by the same token, actual air tonnes amount to 2.5 percent of screened export sea tonnes, indicating a broad base for potential airfreight. Actual air penetration of screened sea tonnes and total sea tonnes has also been caluclated and included in the tables.

To provide further definition of the selected commodity networks, a computer output is available for exports from U.S. to and from destination countries. The report format is known as the "cumulative reports". This Douglas-developed computer program processes U.N. or U.S. foreign trade data and ranks on dollar value all products for a regional flow. The report is used to correlate product value with significant tonnage flows.

A requirement of this study is to identify goods moving in international trade channels which indicate the likelihood that they could be economically transported by air. This preliminary assessment includes an analysis of the structure of today's markets. Tables 1-70 through 1-101 are individual market exhibits of selected annual commodity flows by air and vessel modes of transport. They were selected from special listings of U.S. 1976 exports and imports, mainly on the basis of significant tonnage flows and nominally high average product value. Table 1-90, for example, shows a total of over 3 million tonnes of goods worth 5.5 billion dollars moving from Germany to U.S. in 1976. The air flow at over 41 000 tonnes is a significant amount but still represents only 1.3 percent of total tonnage flow. These tables can be used to begin to understand the magnitude of the markets in terms of numbers of tonnes and numbers of dollars represented. The commodities listed show samples of those that are currently moving by air as well as those moving by the sea mode. In some cases, the same commodities are being shipped by both air and sea. For instance, auto parts are shipped from the U.S. to France both by sea and air.

TABLE 1-70

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to Bolivia - 4878 Air Kilometers

Air Tonnes	2 490	$ 31 900 000
Sea Tonnes	85 008	$ 99 300 000
	87 498	$131 200 000

Air % Tonnes = 2.9%

SITC	Commodities	Tonnes	$ 10^6	$ Kg
	(air)			
71430	Statistical Machines	14	1.0	71.42
73492	Aircraft Parts	38	2.3	60.52
72499	Telecon Equipment	36	1.9	52.77
71141	Internal Combustion Engines	62	2.8	45.16
69524	Hand Tools	63	1.0	15.87
71842	Excavating Equipment	608	7.1	11.68
72410	TV Receivers	213	2.1	9.86
73289	Auto Parts	153	1.5	9.49
	(sea)			
72410	TV Receivers	616	6.2	10.12
71150	Internal Combustion Engines	292	2.2	7.50
71922	Pumps	214	1.4	6.46
71921	Pumps	326	1.7	5.15
71250	Tractors	1 817	8.0	4.42
71842	Excavating Equipment	1 763	7.2	4.09
72210	Electrical Machinery	651	2.5	3.86
71831	Loading Machinery	1 105	4.1	3.72
73289	Auto Parts	1 079	3.1	2.83
73202	Trucks	3 434	8.0	2.34
71919	Cooling Equipment	1 804	3.5	1.92
		14 288	67.6	4.73

TABLE 1-71

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to Brazil	7 725	Air Kilometers
Air Tonnes	15 933	$ 405 100 000
Sea Tonnes	8 278 978	$ 2 330 000 000
	8 294 911	$ 2 735 100 000

Air % Tonnes = 0.2%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
54130	Penicillin	92	17.0	184.12
72952	Electrical Measuring Devices	224	15.3	68.48
73492	Aircraft Parts	727	42.0	57.74
72930	Thermionic	323	18.0	55.58
71492	Parts, Office Machinery	666	27.6	41.46
72499	Telecon Equipment	1 227	44.4	36.19
71980	Mechanical Appliances	233	6.0	25.81
89120	Phonograph Records	246	3.2	13.01
73289	Auto Parts	1 020	10.5	10.30
	(sea)			
72952	Electrical Measuring Devices	583	13.5	23.16
86246	Motion Picture Film	806	14.1	17.46
86169	Photo Equipment	1 282	21.1	16.45
71992	Taps, Valves	1 732	16.3	9.42
72220	Apparatus, Breaking	3 252	27.8	8.53
71510	Machine Tools	10 958	87.6	7.99
71921	Pumps	2 301	16.7	7.28
71150	Internal Combustion Engines	4 872	32.5	6.67
71922	Pumps	4 078	24.5	6.01
71980	Mechanical Appliances	6 657	39.8	5.98
71919	Cooling Equipment	5 895	32.1	5.44
73289	Auto Parts	11 760	56.3	4.78
71931	Loading Machinery	15 016	56.2	3.74
		73 950	622.5	8.42

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TABLE 1-72

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to UK	5 535 Air Kilometers	
Air Tonnes	59 726	$ 1 660 300 000
Sea Tonnes	5 987 431	$ 2 864 500 000
	6 047 157	$ 4 524 800 000

Air % Tonnes = 1.0%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72499	Telecommunications Equipment	607	73.5	121.17
73492	Aircraft Parts	795	71.2	89.60
72952	Electrical Measuring Devices	1 265	88.2	69.77
71430	Statistical Machines	1 404	89.5	63.70
71492	Parts Office Machines	4 655	223.8	48.07
71980	Mechanical Appliances	1 302	32.6	25.03
86169	Photo Equipment	951	16.9	17.70
89120	Phonograph Records	895	11.1	12.36
73289	Auto Parts	2 250	15.7	6.97
	(sea)			
51203	Sulfa Drugs	1 395	32.6	23.37
86246	Motion Picture Film	1 352	21.7	16.03
71980	Mechanical Appliances	3 589	26.9	7.49
71510	Machine Tools	4 680	34.4	7.36
71922	Pumps	2 885	18.6	6.43
71842	Excavating Equipment	27 647	138.5	5.01
73289	Auto Parts	19 730	71.3	3.61
		75 402	966.5	12.82

TABLE T-73

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to France	6 069 Air Kilometers	
Air Tonnes	45 552	$ 1 268 500 000
Sea Tonnes	7 060 244	$ 1 991 900 000
	7 105 796	$ 3 260 400 000

Air % Tonnes = 0.7%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72952	Electrical Measuring Devices	924	71.0	76.76
71430	Statistical Machinery	908	60.0	66.03
71492	Office Machine Parts	3 940	222.1	56.36
71980	Mechanical Appliances	981	26.5	27.03
86169	Photographic Equipment	473	10.5	22.16
73100	Personal Effects	2 058	28.7	13.94
73289	Auto Parts	1 677	16.7	9.97
	(sea)			
86246	Motion Picture Film	763	15.9	20.87
55110	Essential Oils	1 040	10.4	10.03
71510	Machine Tools	2 121	17.3	8.15
89424	Indoor Game Equipment	2 248	16.1	7.17
71922	Pumps	2 696	17.7	6.55
71980	Mechanical Appliances	2 006	12.7	6.35
73920	Thermionic Valves	5 116	26.7	4.43
73289	Auto Parts	14 706	56.9	3.87
65229	Cotton Fabrics	16 776	66.4	3.84
		58 433	675.6	11.56

TABLE 1-74

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to West Germany		6 186 Air Kilometers
Air Tonnes	48 175	$ 1 593 200 000
Sea Tonnes	14 439 145	$ 3 823 700 000
	14 487 320	$ 5 416 900 000

Air % Tonnes = 0.3%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
73492	Aircraft Parts	1 188	123.3	103.69
71430	Statistical Machines	1 092	74.2	67.93
72952	Electrical Measuring Devices	1 472	95.8	65.01
71492	Parts Office Machines	4 578	228.5	49.93
86169	Photographic Equipment	2 521	40.7	16.14
	(sea)			
86246	Motion Picture Film	2 592	55.1	21.25
71510	Machine Tools	1 638	15.2	9.26
71980	Mechanical Appliances	1 470	11.4	7.75
85243	Cloth, Sensitized	1 696	12.5	7.35
71923	Filtering Equipment	1 004	7.3	7.28
71921	Pumps	1 166	7.5	6.40
72210	Electrical Machines	4 106	23.5	5.72
71915	Refrigerators	3 489	17.5	5.02
		28 012	712.5	25.43

TABLE 1-75

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to Italy	6 860 Air Kilometers	
Air Tonnes	18 943	$ 643 300 000
Sea Tonnes	12 047 591	$ 2 208 700 000
	12 066 534	$ 2 852 000 000

Air % Tonnes = 0.2%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72952	Electrical Measuring Devices	516	37.5	72.60
71492	Office Machine Parts	1 740	74.8	43.02
93100	Personal Effects	970	15.1	15.57
02500	Eggs	461	2.1	4.38
	(sea)			
86246	Picture Film	1 235	23.2	18.81
71970	Ball Bearings	496	5.5	11.16
71980	Mechanical Appliances	953	7.4	7.76
71923	Filtering Equipment	397	2.8	7.10
71510	Mechanical Tools	1 978	12.8	6.49
71150	Internal Combustion Engines	2 658	16.1	6.04
73289	Auto Parts	1 760	9.7	5.53
71842	Leveling Equipment	4 701	22.6	4.81
65229	Cotton Fabrics	19 287	74.1	3.84
		37 152	303.7	8.17

TABLE 1-76

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to Iran	9 838 Air Kilometers	
Air Tonnes	16 894	$ 631 000 000
Sea Tonnes	1 907 202	$ 1 415 700 000
	1 924 096	$ 2 046 700 000

Air % Tonnes = 0.9%

SITC	Commodities	Tones	$ 10^6	$/Kg
	(air)			
73492	Aircraft Parts	4 844	324.3	66.96
71980	Mechanical Appliances	474	9.8	20.59
71842	Excavation Equipment	732	11.9	16.23
93100	Personal Effects	1 412	15.5	10.95
73289	Auto Parts	372	3.2	8.52
	(sea)			
72499	Telecommunications Equipment	668	23.0	34.34
72491	Telephone Equipment	731	19.8	27.04
71160	Gas Turbines	2 174	40.3	18.52
73492	Aircraft Parts	1 921	34.7	18.05
69524	Hand Tools	543	6.7	12.34
71992	Pumps	3 214	28.2	8.78
71150	Internal Combustion Engines	3 793	26.6	7.02
12220	Cigarettes	8,038	49.0	6.09
72210	Electrical Machinery	5,816	32.7	5.62
11980	Mechanical Appliances	6,402	33.5	5.24
		41.134	659.2	16.03

TABLE 1-77

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to Indonesia	13 938	Air Kilometers
Air Tonnes	1 609	$ 77 300 000
Sea Tonnes	1 183 950	$ 841 900 000
	1 185 559	$ 919 200 000

Air % Tonnes = 0.1%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72499	Telecommunications Equipment	206	24.6	119.58
93100	Personal Effects	105	1.9	17.97
71842	Excavation Equipment	101	1.4	13.90
	(sea)			
72499	Telecommunications Equipment	924	40.4	43.68
71160	Gas Turbines	506	7.5	14.84
72210	Electrical Power Machines	8 038	84.6	10.53
71992	Taps, Valves	1 203	10.4	8.63
71921	Pumps	1 997	16.7	8.35
72220	Apparatus, Breaking	1 354	10.7	7.88
71919	Cooling Equipment	3 478	16.9	4.86
71842	Leveling Equipment	12 091	53.8	4.45
		30 003	268.9	8.96

TABLE 1-78

U.S. INTERNATIONAL COMMODITY NETWORKS

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U.S. to Hong Kong	11 097 Air Kilometers		
Air Tonnes	6 672	$ 267 700 000	
Sea Tonnes	764 094	$ 1 293 500 000	
	770 766	$ 1 561 200 000	

Air % Tonnes = 0.9%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72930	Thermionic Valves	977	114.3	117.02
71492	Parts Office Machines	511	52.3	102.27
89521	Fountain Pens	211	6.4	30.12
71980	Mechanical Appliances	254	6.9	27.7
93100	Personal Effects	359	2.8	7.83
	(sea)			
72499	Telecommunications Equipment	220	6.5	29.38
86246	Picture Film	746	17.0	22.77
71730	Sewing Machines	338	3.7	10.93
26622	Filament	630	5.7	9.08
72492	Microphones	394	2.8	7.21
89424	Indoor Games	385	2.5	6.49
12220	Cigarettes	8 396	48.3	5.75
89120	Phonograph Records	1 464	7.9	5.40
56120	Medicaments	937	4.5	4.78
		15 822	281.6	17.80

TABLE 1-79

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to Taiwan	10 895 Air Kilometers	
Air Tonnes	5 773	$ 335 500 000
Sea Tonnes	3 165 115	$ 618 500 000
	3 170 888	$ 954 000 000

Air % Tonnes = 0.2%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
86411	Watch and Clock Movements	181	40.0	221.28
72410	TV Receivers	389	10.2	26.27
72220	Apparatus, Breaking	182	6.3	34.65
71980	Mechanical Appliances	237	7.5	31.63
72499	Telecommunications Equipment	458	14.2	31.06
58110	Plastic Rolls	186	0.9	4.70
	(sea)			
73492	Aircraft Parts	1 792	74.8	41.70
71170	Nuclear Reactors	458	6.3	13.64
72499	Telecommunications Equipment	1 172	13.8	11.78
71992	Tops, Valves	1 675	16.9	10.06
72220	Electrical Apparatus	1 595	14.1	8.84
72210	Electrical Power	5 109	37.8	7.41
71923	Filtering Equipment	1 260	9.1	7.20
71922	Pumps	2 345	14.0	5.96
12100	Tobacco, Unmanufactured	6 281	19.5	3.10
		23 320	285.4	12.24

TABLE 1-80

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to Japan	8 808 Air Kilometers			
Air Tonnes	36 970	$	412 700 000	
Sea Tonnes	61 286 420	$ 1	676 100 000	
	61 323 390	$ 2	088 800 000	

Air % Tonnes = 0.06%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72930	Thermionic Valves	409	110.9	271.02
71430	Statistical Machines	758	79.3	104.63
73492	Aircraft Parts	709	72.5	102.32
72952	Electrical Measuring Devices	1 046	82.7	79.13
71492	Office Machine Parts	2 136	133.7	62.60
93100	Personal Effects	2 010	15.6	7.75
	(sea)			
54170	Medicaments	1 021	25.4	24.87
86246	Picture Film	3 400	59.4	17.46
89442	Sporting Goods	1 908	30.2	15.80
71170	Nuclear Reactors	2 263	22.1	9.79
71510	Machine Tools	2 923	26.7	9.11
72492	Loudspeakers	2 118	16.6	7.81
03120	Fish	6 042	39.3	6.50
12220	Cigarettes	3 242	18.0	5.56
		29 985	732.4	24.42

TABLE 1-81

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to Australia	12 053 Air Kilometers		
	Air Tonnes	12 764	$ 1 400 000 000
	Sea Tonnes	1 802 054	$ 8 508 100 000
		1 814 818	$ 9 908 100 000

Air % Tonnes = 0.7%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
71142	Jet Engines	178	24.4	137.08
73492	Aircraft Parts	495	41.5	83.71
71492	Office Machine Parts	825	51.8	62.67
51203	Sulfa Drugs	371	6.9	18.46
89120	Phonograph Records	253	3.9	15.54
93100	Personal Effects	2 081	21.0	10.08
73289	Auto Parts	637	5.2	8.11
	(sea)			
73410	Aircraft	401	12.0	29.92
73492	Aircraft Parts	800	21.4	26.71
86246	Motion Picture Film	1 182	20.0	16.85
72220	Apparatus, Breaking	1 089	12.1	11.06
86171	Medical Instruments	494	4.2	8.59
89120	Phonograph Records	950	7.4	7.81
71921	Pumps	840	6.1	7.29
71510	Machine Tools	1 061	7.4	6.93
71150	Combustion Engines	15 638	82.7	5.29
		27 295	328.0	12.01

TABLE 1-82

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to Nigeria	8 440 Air Kilometers	
Air Tonnes	4 088	$ 119 000 000
Sea Tonnes	919 546	$ 575 500 000
	923 634	$ 694 500 000

Air % Tonnes = 0.4%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72499	Telecommunications Equipment	735	62.9	85.51
86171	Medical Instruments	89	3.2	35.83
71842	Excavation Equipment	446	5.5	12.29
	(sea)			
72499	Telecommunications Equipment	323	5.7	17.67
71852	Glass Machinery	236	3.7	15.46
73289	Auto Parts	1 291	12.0	9.29
73101	Diesel Locomotives	1 099	9.8	8.93
71923	Filtering Equipment	2 298	19.8	8.60
73204	Buses	3 790	27.4	7.24
72210	Electrical Machinery	1 160	7.7	6.68
71932	Forklift Truck	1 789	9.8	5.48
71915	Refrigerators	1 208	6.0	4.97
71931	Loading Machines	2 860	11.4	3.99
71250	Tractors	6 889	26.9	3.91
		24 213	211.8	8.74

TABLE 1-83

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to S. Africa	12 553 Air Kilometers		
Air Tonnes	5 728	$	210 400 000
Sea Tonnes	869 847	$	915 300 000
	874 575	$ 1	125 700 000

Air % Tonnes = 0.7%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
71141	Internal Combustion Engines	218	32.3	148.54
71492	Office Machine Parts	310	18.1	58.39
86199	Parts of Measuring Equipment	100	4.1	41.35
93100	Personal Effects	591	9.7	16.49
73289	Auto Parts	431	3.6	8.31
	(sea)			
69524	Hand Tools	364	7.1	19.49
86246	Film	474	8.4	17.71
72220	Apparatus, Breaking	940	8.4	8.87
69523	Hand Tools	414	2.9	7.09
71150	Engines	3 490	24.0	6.86
71921	Pumps	1 059	7.2	6.79
71510	Machine Tools	1 161	7.6	6.56
71980	Mechanical Appliances	1 646	10.7	6.52
		11 198	144.1	12.86

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TABLE 1-84

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to Venezuela 3 417 Air Kilometers

Air Tonnes	40 172	$ 438 000 000
Sea Tonnes	3 013 350	$ 2 054 100 000
	3 053 522	$ 2 492 100 000

Air % Tonnes = 1.3%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72952	Electrical Measuring Devices	261	12.7	48.99
71492	Office Machine Parts	244	11.2	45.96
73492	Aircraft Parts	259	8.7	33.56
09910	Food NEC	412	11.9	28.75
72499	Telecommunications Equipment	703	15.7	22.32
73289	Auto Parts	8 479	53.3	6.29
	(sea)			
86171	Medical Instruments	236	3.2	13.48
55120	Synthetic Perfume	274	3.0	11.00
69524	Hand Tools	416	4.4	10.59
72499	Other Telecommunications Equip.	278	2.7	9.54
71962	Machine Cleaning	1 437	12.1	8.45
71992	Taps and Valves	1 661	10.5	6.33
72220	Apparatus for Breaking	2 820	15.6	5.54
71980	Mechanical Appliances	5 816	31.2	5.36
71922	Pumps for Gases	5 607	28.6	5.11
71150	Internal Combustion Engines	5 152	26.0	5.04
69523	Hand Tools	1 088	5.0	4.60
72210	Electrical Power Machines	10 014	34.6	3.45
73289	Auto Parts	31 791	91.5	2.88
		76 948	381.9	4.96

TABLE 1-85

U.S. INTERNATIONAL COMMODITY NETWORKS

U.S. to Morocco	5 593 Air Kilometers	
Air Tonnes	547	$ 23 300 000
Sea Tonnes	645 081	$ 182 300 000
	645 628	$ 205 600 000

Air % Tonnes = 0.1%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
73492	Aircraft Parts	70	7.2	102.87
72499	Telecommunications Equipment	102	6.5	63.12
73289	Auto Parts	26	0.3	12.37
	(sea)			
72499	Telecommunications Equipment	21	0.8	34.76
71150	Internal Combustion Engines	256	1.9	7.28
73289	Auto Parts	1063	7.6	7.12
72210	Electrical Machines	104	0.7	6.74
71842	Excavating Equipment	1574	10.0	6.29
73330	Trailers and Vehicles	1592	8.3	5.18
12220	Cigarettes	700	3.7	5.31
71713	Weaving Machines	358	1.0	2.88
65352	Woven Fabrics	642	1.7	2.62
		6508	49.7	7.64

TABLE 1-86

U.S. INTERNATIONAL COMMODITY NETWORK

Bolivia to U.S.	4 878 Air Kilometers	
Air Tonnes	430	$ 4 200 000
Sea Tonnes	292 009	$ 108 800 000
	292 439	$ 113 000 000

Air % Tonnes = 0.2%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
94100	Animals	11	0.5	39.37
69524	Hand Tools	23	0.6	25.53
93100	Personal Effects	263	2.0	7.52
	(sea)			
68710	Tin Alloys	1986	14.2	7.14
28392	Tungston Ore	780	4.7	5.98
07110	Coffee	1607	3.5	2.18
		4670	25.5	5.46

TABLE 1-87

U.S. INTERNATIONAL COMMODITY NETWORK

Brazil to U.S.	7 725 Air Kilometers	
Air Tonnes	13 291	$ 155 300 000
Sea Tonnes	7 170 771	$ 1 576 600 000
	7 184 062	$ 1 731 900 000

Air % Tonnes = 0.2%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72941	Ignition Equipment	323	11.7	36.07
72420	Radio Receivers	442	12.2	32.90
72930	Thermionic Valves	320	9.2	28.78
84130	Clothing & Apparel	341	6.3	18.33
72220	Electrical Equipment	226	3.0	13.18
83100	Travel Goods	816	8.0	9.78
85102	Footwear Leather	7 070	46.7	6.61
	(sea)			
72420	Radio Receivers	2 056	40.0	19.42
03130	Crustacea	3 649	30.0	8.20
68710	Tin Alloys	1 282	9.2	7.18
85102	Leather Footwear	16 342	93.7	5.73
07130	Coffee Extracts	25 677	121.5	4.73
		58 544	391.5	6.69

TABLE 1-88

U.S. INTERNATIONAL COMMODITY NETWORKS

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U.K. to U.S.	5 535 Air Kilometers		
Air Tonnes	41 572	$ 1 090 000 000
Sea Tonnes	3 480 010	$ 2 793 100 000
	3 521 582	$ 3 883 100 000

Air % Tonnes = 1.2%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
71142	Jet Engines	487	72.1	147.98
73492	Aircraft Parts	486	55.1	113.22
71150	Internal Combustion Engines	1 597	128.6	80.54
72620	X-Ray Apparatus	568	34.4	60.60
72952	Electrical Measuring Devices	566	32.1	56.70
84144	Garments	561	17.0	30.22
93100	Personal Effects	5 553	106.9	19.25
	(sea)			
89211	Books	680	7.5	11.03
86241	Photo Film	724	9.2	12.61
71491	Duplicating Machines	1 582	13.5	8.54
71980	Mechanical Appliances	4 885	30.0	6.14
66640	Porcelain, China	2 164	12.8	5.93
71921	Pumps	2 967	16.7	5.62
89111	Tape Recorder	19 504	90.4	4.63
89211	Books	10 267	44.9	4.38
71510	Machine Tools	10 897	28.3	2.60
73280	Auto Parts	42 319	76.1	1.80
		105 807	775.6	7.33

TABLE 1-89

U.S. INTERNATIONAL COMMODITY NETWORKS

France to U.S.	6 069 Air Kilometers		
Air Tonnes	23 644	$	636 400 000
Sea Tonnes	2 394 509	$	1 750 200 000
	2 418 153	$	2 386 600 000

Air % Tonnes = 1.0%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
71492	Machine Parts	288	35.9	124.45
86121	Spectacle Frames	377	26.4	70.03
84112	Girls Garments	796	34.7	43.59
84111	Mens Garments	1 188	28.9	24.35
55300	Perfumery	690	11.5	16.69
89442	Archery/Tennis Equipment	871	6.1	6.97
02400	Cheese	826	3.0	3.57
	(sea)			
55110	Resinoids	740	10.8	14.60
89442	Skis - Tennis Equipment	2 548	26.0	10.18
07130	Coffee Extracts	3 013	26.3	8.73
71980	Mechanical Appliances	1 904	15.6	8.18
55300	Perfumery	2 145	16.0	7.43
71919	Cooling Equipment	5 322	22.1	4.16
73210	Autos	21 998	69.0	3.13
62910	Rubber Tires	50 466	119.1	2.36
		93 172	451.4	4.84

TABLE 1-90

U.S. INTERNATIONAL COMMODITY NETWORKS

West Germany to U.S.		6 186	Air Kilometers	
	Air Tonnes	41 548	$	805 300 000
	Sea Tonnes	3 250 372	$	4 635 700 000
		3 291 920	$	5 441 000 000
	Air % Tonnes	=	1.3%	

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
86121	Spectacle Frames	131	16.2	123.73
86171	Medical Instruments	707	34.6	48.94
71713	Machine Weaving	580	21.8	37.59
72220	Electrical Apparatus	795	23.4	29.41
93100	Personal Effects	4 140	77.9	18.81
71980	Mechanical Appliances	1 144	18.4	16.13
	(sea)			
72620	X-Ray Apparatus	2 676	49.2	18.37
71953	Hand Tools, Mechanical	1 696	23.4	13.81
71410	Typewriters	5 630	62.8	11.15
85102	Footwear, Leather	1 659	16.4	9.86
71980	Mechanical Appliances	9 314	70.0	7.52
71829	Printing Machines	5 920	40.0	6.71
71921	Pumps	5 128	31.7	6.18
71919	Cooling Equipment	10 578	50.3	4.76
73210	Autos	361 240	1 619.0	4.48
73280	Auto Parts	43 737	129.6	2.96
		455 075	2 283.7	5.02

TABLE 1-91

U.S. INTERNATIONAL COMMODITY NETWORKS

Italy to U.S.	6 860 Air Kilometers		
Air Tonnes	36 495	$	693 800 000
Sea Tonnes	3 751 787	$	1 802 700 000
	3 788 282	$	2 496 500 000
Air % Tonnes =	1.0%		

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
54170	Medicaments	154	11.8	76.52
51200	Organic Chemicals	453	25.4	56.08
84111	Men's Garments	443	14.8	33.31
83100	Handbags	1 146	21.4	18.68
85102	Footwear, Leather	11 505	138.3	12.02
	(sea)			
71962	Machines for Filling	662	12.9	19.52
71712	Knitting Machines	944	8.3	8.74
85101	Footwear	6 912	47.8	6.91
85102	Footwear, Leather	20 938	139.8	6.68
71730	Sewing Machines	2 312	13.2	5.70
71919	Heating Equipment	3 760	18.0	4.78
73291	Motorcycle Parts	3 625	16.7	4.59
73210	Autos	78 610	269.6	3.43
06210	Sugar, Confectionery	5 318	11.0	2.07
		138 797	797.9	5.75

TABLE 1-92

U.S. INTERNATIONAL COMMODITY NETWORKS

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Iran to U.S.	9 838 Air Kilometers		
Air Tonnes	524	$	18 100 000
Sea Tonnes	15 403 128	$	1 461 400 000
	15 403 652	$	1 479 500 000

Air % Tonnes = 0%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
65750	Carpets	143	5.6	39.09
93100	Personal Effects	302	7.2	23.79
	(sea)			
65750	Carpets	718	16.1	22.46
03130	Crustacea	587	2.1	3.66
21170	Sheepskin	9 435	31.1	3.29
05172	Nuts	5 880	17.5	2.97
		17 065	79.6	4.66

TABLE 1-93

U.S. INTERNATIONAL COMMODITY NETWORKS

Indonesia to U.S.	13 938 Air Kilometers	
Air Tonnes	528	$ 9 800 000
Sea Tonnes	27 275 813	$ 2 979 200 000
	27 276 341	$ 2 989 000 000

Air % Tonnes = 0%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72994	Electrical Signals	212	4.4	20.96
93100	Personal Effects	156	1.4	8.45
03100	Fish	45	0.3	5.27
	(sea)			
68710	Tin	4 985	35.2	7.05
55110	Resinoids	955	5.6	5.83
03130	Crustacea	2 087	7.5	3.61
07110	Coffee	66 501	105.0	1.58
		74 941	159.4	2.13

C-3

TABLE 1-94

U.S. INTERNATIONAL COMMODITY NETWORKS

Hong Kong to U.S.	11 097 Air Kilometers		
Air Tonnes	45 827	$	743 400 000
Sea Tonnes	441 116	$	1 571 300 000
	486 943	$	2 314 700 000

Air % Tonnes = 10.4%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
86411	Watches	192	29.6	153.70
72930	Thermionic Valves	2 618	85.2	32.53
89720	Jewelry	1 344	23.5	17.46
84144	Knit Garments	7 888	112.4	14.25
84112	Women's garments	8 016	86.8	10.83
84111	Men's Garments	3 957	36.1	9.13
89424	Game Equipment	1 872	9.5	5.07
	(sea)			
84144	Outer Garments	10 924	106.8	9.78
84143	Knit Garments	8 893	80.1	9.01
84112	Women's Garments	27 410	195.5	7.13
72420	Radio Receivers	19 306	136.3	7.06
84111	Men's Garments	16 094	113.2	7.04
84113	Boys Garments	10 453	66.3	6.53
		118 967	1 081.3	9.09

TABLE 1-95

U.S. INTERNATIONAL COMMODITY NETWORKS

Taiwan to U.S.	10 895 Air Kilometers	
Air Tonnes	28 085	$ 418 300 000
Sea Tonnes	1 533 086	$ 2 557 700 000
	1 561 171	$ 2 976 000 000

Air % Tonnes = 0.2%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72930	Valves	684	65.7	96.03
86140	Cameras	280	17.6	62.89
84130	Apparel	864	16.2	18.75
72499	Telecommunications Equipment	1 967	31.5	16.05
84143	Garments	2 813	31.0	11.04
84144	Garments	4 895	45.0	9.18
	(sea)			
84143	Garments	9 796	81.8	8.35
84130	Clothing	5 004	37.6	7.52
72420	Radio Receivers	11 731	82.1	7.00
84144	Garments	34 188	225.9	6.61
72499	Telecommunications Equipment	23 179	150.6	6.50
72410	TV Receivers	30 235	187.4	6.20
		125 637	972.4	7.74

TABLE 1-96

U.S. INTERNATIONAL COMMODITY NETWORKS

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Japan to U.S.	8 808 Air Kilometers	
Air Tonnes	80 098	$ 1 621 900 000
Sea Tonnes	12 416 974	$ 13 809 800 000
	12 497 072	$ 15 431 700 000

Air % Tonnes = 0.7%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
71430	Statistical Machines	492	40.1	81.49
86140	Cameras	1 614	112.8	69.82
86112	Optical Elements	1 090	55.4	50.81
72499	Telecommunications Equipment	17 962	385.8	21.48
71420	Calculating Machines	6 505	98.9	15.20
89111	Gramophones	4 272	62.4	14.62
	(sea)			
71420	Calculating Machines	9 718	134.1	13.80
71491	Duplicating Machines	11 570	106.5	9.20
72499	Telecommunications Equipment	65 014	573.4	8.82
89111	Gramophones	69 004	598.6	8.67
72410	TV Receivers	77 956	583.5	7.48
71730	Sewing Machines	16 680	95.2	5.21
93292	Motorcycle Parts	7 782	37.7	4.85
73291	Motorcycle Parts	101 235	413.8	4.09
		390 894	3 298.2	8.44

TABLE 1-97

U.S. INTERNATIONAL COMMODITY NETWORKS

Australia to U.S.	12 053 Air Kilometers		
Air Tonnes	2 292	$	58 600 000
Sea Tonnes	5 165 912	$ 1	138 300 000
	5 168 204	$ 1	196 900 000

Air % Tonnes = 0.04%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
73492	Aircraft Parts	63	3.3	52.44
93100	Personnal Effects	672	22.3	33.22
54199	Pharmaceutical Goods	79	1.6	20.58
03130	Crustacea	153	2.0	12.82
89442	Nets, Skis	92	0.4	3.41
	(sea)			
03130	Crustacea	5 256	53.3	10.15
68130	Nickel Alloy	3 468	16.1	4.62
26210	Sheep Wool	12 520	20.1	2.24
		22 303	119.1	5.34

TABLE 1-98

U.S. INTERNATIONAL COMMODITY NETWORKS

Nigeria to U.S.	8 440 Air Kilometers		
Air Tonnes	106	$	1 500 000
Sea Tonnes	50 339 218	$ 4 935 900 000	
	50 339 324	$ 4 937 400 000	

Air % Tonnes = 0%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
93100	Personal Effects	44	1.1	23.30
03100	Fish	53	0.3	4.78
	(sea)			
21170	Sheep Wool	272	1.6	5.71
21160	Lamb Wool	279	1.2	4.25
28399	Ores	222	0.7	3.34
		870	4.9	5.63

TABLE 1-99

U.S. INTERNATIONAL COMMODITY NETWORKS

S. Africa to U.S.	12 553 Air Kilometers	
Air Tonnes	534	$ 270 700 000
Sea Tonnes	2 228 585	$ 362 500 000
	2 229 119	$ 633 200 000

Air % Tonnes = 0%

SITC	Commodities	Tonnes	$ 10^6	S/Kg
	(air)			
93100	Personal Effects	170	6.1	35.84
89211	Books	33	0.1	1.33
	(sea)			
03130	Crustacea	3368	35.7	10.59
93100	Personal Effects	1244	5.9	4.75
68310	Nickel Alloys	2444	10.4	4.26
21170	Lambs Wool	358	1.2	3.41
		7617	59.4	7.80

TABLE 1-100

U.S. INTERNATIONAL COMMODITY NETWORKS

Venezuela to U.S.	3 418 Air Kilometers	
Air Tonnes	7 174	$ 40 600 000
Sea Tonnes	52 126 980	$ 3 521 900 000
	52 134 154	$ 3 562 500 000

Air % Tonnes = 0%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
03130	Crustacea	3 186	17.6	5.52
03202	Mollusks	581	1.9	3.26
03120	Fish, Dried	138	0.4	2.36
	(sea)			
71910	Cooling Equipment	35	0.2	6.03
03130	Crustacea	105	0.6	5.45
07232	Coca Butter	295	1.0	3.17
93100	Personal Effects	4 691	10.0	2.13
07110	Coffee	17 559	35.0	1.99
		26 590	66.7	2.51

TABLE 1-101

U.S. INTERNATIONAL COMMODITY NETWORKS

Morocco to U.S.	5 593 Air Kilometers	
Air Tonnes	316	$ 4 700 000
Sea Tonnes	134 809	$ 11 500 000
	135 125	$ 16 200 000

Air % Tonnes = 0.3%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(sea)			
65750	Carpets	34	0.3	7.93
29291	Vegetable Extracts	90	0.6	6.99
65220	Cotton Fabrics	158	0.4	2.69
05450	Fresh Vegetables	520	0.8	1.51
		802	2.1	2.62

U.S. international airfreight markets. - The relationship of international airfreight transport to external trade is similar to that of passenger tourism in that an understanding of developments require a general awareness of trade or tourism patterns, whichever the case. Figure 1-37 shows the basic data flow for U.S. international airfreight markets. As noted previously, U.S. trade data with all partner countries are available in terms of both dollar value and weight at the SITC five-digit level. This universal data set provides a well-documented cross section of the current status of air transport in interregional freight markets. Figure 1-38 (Reference 1-26) traces the tonne-kilometer growth from 1960 to 1976 for airfreight carried by all classes of U.S. air carriers. Over the full period the annual growth rate exceeded 44 percent. From 1968, growth occurred at a 12-percent annual rate.

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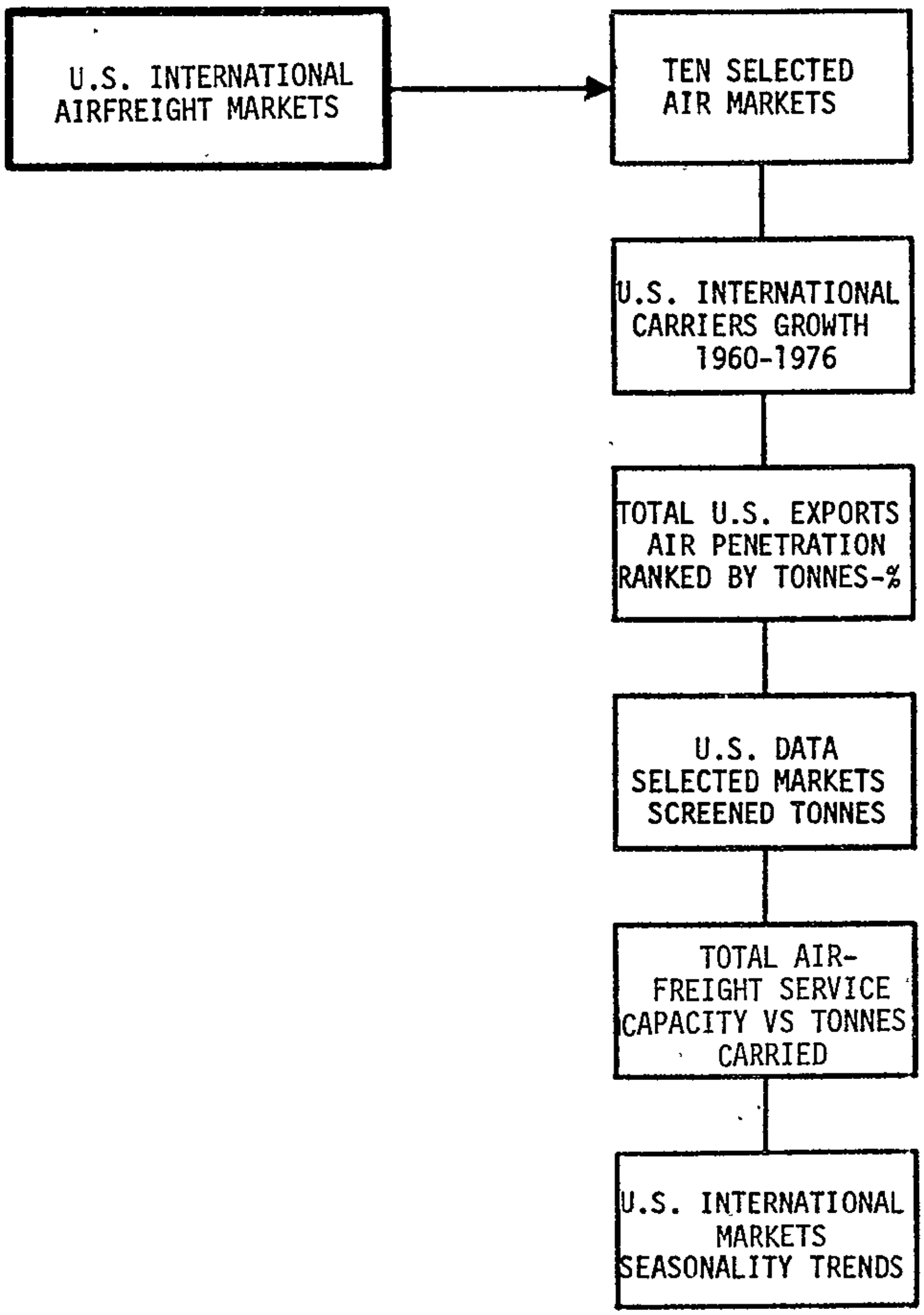

Figure 1-37. U.S. International Airfreight Markets Data Flow

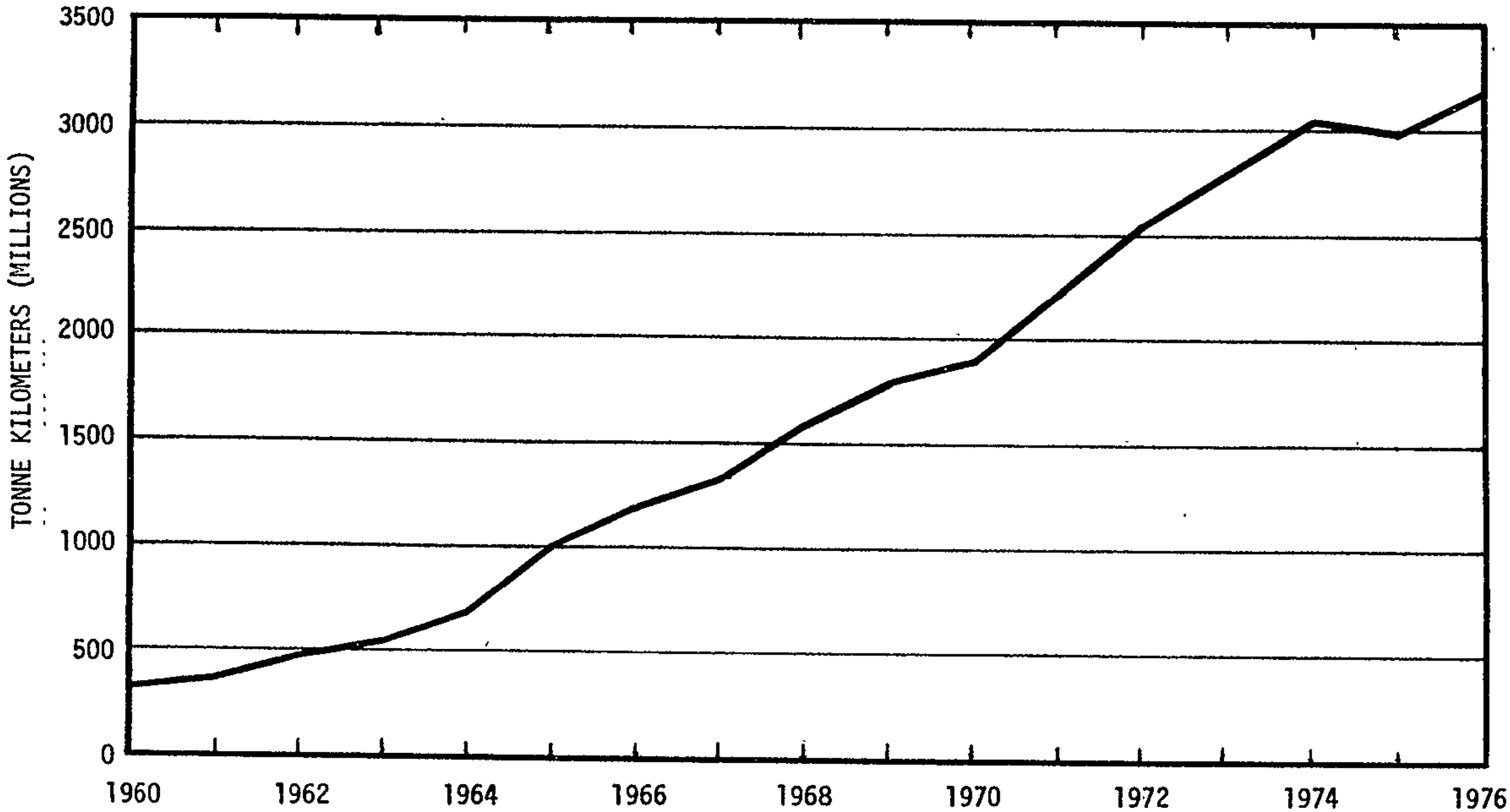

Figure 1-38. U.S. International Scheduled Airfreight Traffic - 1960-1976

The task of evaluating U.S. international airfreight markets presented a problem similar to that in the U.S. commodity networks. The following markets were chosen relative to the commodity networks established above.

Selected U.S. International Airfreight Markets

1. NYC to Germany
2. NYC to UK
3. NYC to Brazil
4. Los Angeles to Japan
5. Los Angeles to Indonesia
6. Germany to NYC
7. UK to NYC
8. Brazil to NYC
9. Japan to Los Angeles
10. Indonesia to Los Angeles

These markets were chosen mainly on the basis of their ability to generate airfreight tonnage. One of the exceptions was the Indonesian market. It was selected because of its key geographical location in the Pacific area, and its growth potential based on natural resources and available labor.

Computer outputs are available from a program which processes the total export and import data bases by customs district and country pair. The program sorts high to low on both sea and air tonnes. Table 1-102 lists the 10 selected airfreight markets for analysis. Data for air tonnes, screened sea tonnes, and total sea tonnes have been tabulated to show the magnitude differential; air percentage of sea has also been computed. It is significant to note that of these 10 international markets, screened commodity tonnes drops to only 25 percent or 5.1 million tonnes from 20.0 million tonnes. This narrows the magnitude of the more likely air-eligible product spectrum. Total air tonnes have been projected onto a world map in Figure 1-39.

TABLE 1-102

SELECTED U.S. INTERNATIONAL AIRFREIGHT MARKETS

Selected Markets	Total Air Tonnes	Screened Sea Tonnes	Total Sea Tonnes	Air % of Screened Sea	Air % of Total Sea
NYC to Germany	30 272	199 853	241 005	15.1	11.1
Germany to NYC	26 386	570 442	655 852	4.6	3.9
NYC to UK	34 542	262 604	498 183	13.2	6.5
UK to NYC	21 910	500 176	882 362	4.4	2.4
NYC to Brazil	9 927	138 223	153 317	7.2	6.1
Brazil to NYC	10 354	214 413	254 584	4.8	4.1
LAX to Japan	9 047	714 930	2 324 730	1.2	0.4
Japan to LAX	22 948	2 408 832	2 426 708	1.0	1.0
LAX to Indonesia	512	34 264	53 949	1.5	1.0
Indonesia to LAX	67	10 165	13 310 442	0.7	-
	165 965	5 080 902	20 801 132	3.3	0.8

Historical air tonnes (1967-1976) were developed for the 10 pilot U.S. international airfreight markets. Table 1-103 tabulates the air tonnage flow for beginning (1967) and ending years (1976). Average growth rates were computed for the 9 years and are indicated for the custom district-country flow. The same data were organized for total U.S. to these same countries and are also tabulated. On balance, it can be observed that U.S. growth overall is higher than custom district growth for the markets. The individual trends are plotted in Figures 1-40 and 1-41 where the disparity in growth is more obvious. Table 1-104 lists the actual air tonnes carried per year from 1972 through 1976 in addition to percentage gain or loss by year.

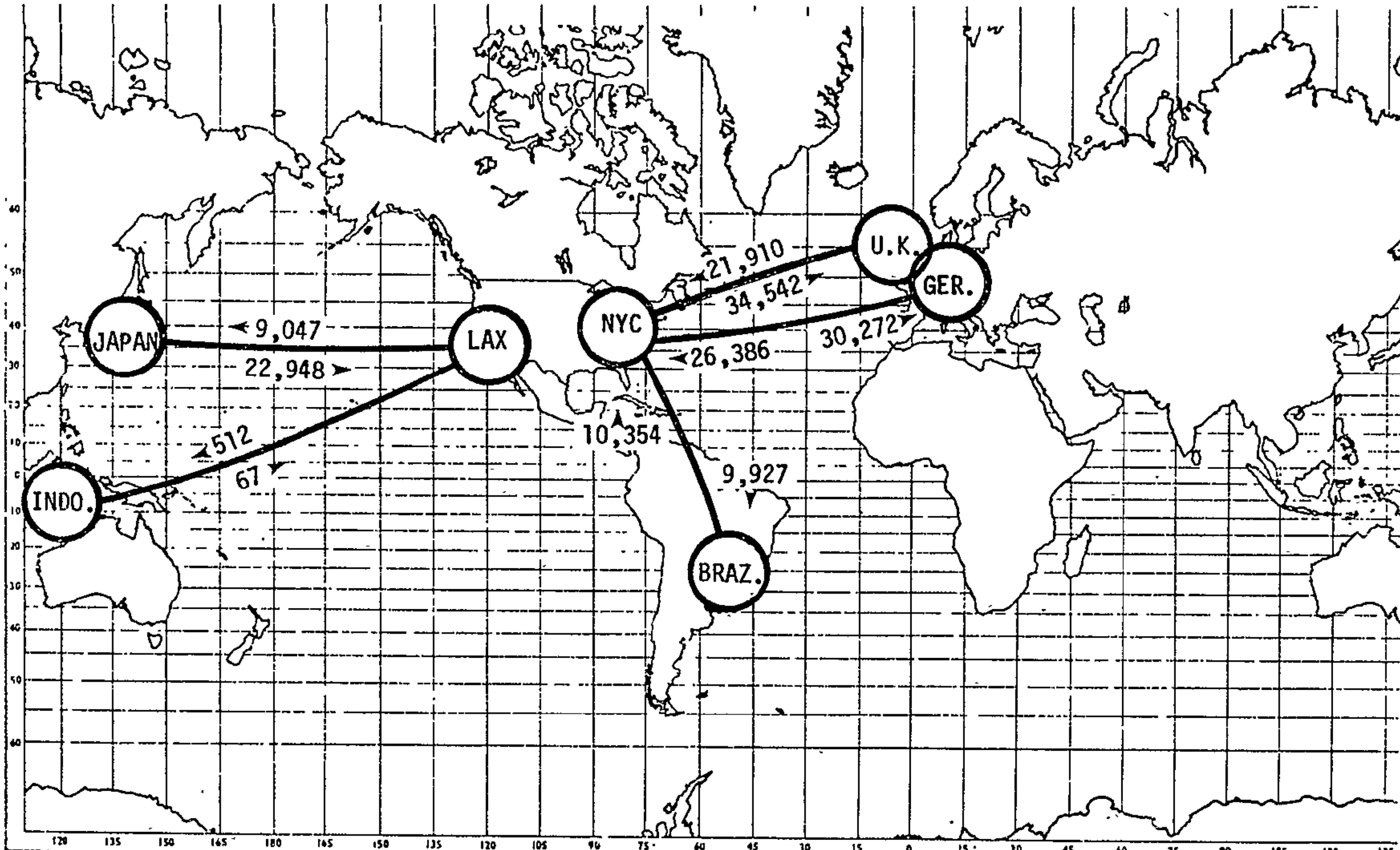

Figure 1-39. U.S. International Airfreight Markets, 1976 Air Tonnes Exports/Imports

TABLE 1-103

SELECTED U.S. INTERNATIONAL AIRFREIGHT MARKETS

9-YEAR GROWTH

Markets	By Market Custom District			All U.S. Customs Districts		
	Tonnes		Avg. Annual Rate	Tonnes		Avg. Annual Rate
	1967	1976	%	1967	1976	%
Markets (exports)						
NYC to Germany	15 237	30 272	11	20 089	48 175	16
NYC to UK	21 199	34 542	7	29 951	59 726	11
NYC to Brazil	1 837	9 927	49	2 794	15 933	52
LAX to Japan	1 674	9 047	48	10 208	36 970	29
LAX to Indonesia	45	512	115	153	1 609	105
Five Market Average			12.3			17.4
Markets (imports)						
Germany to NYC	15 893	26 386	7	20 492	41 548	11
UK to NYC	10 101	21 910	13	15 992	41 572	18
Brazil to NYC	327	10 354	340	526	13 291	269
Japan to LAX	1 357	22 948	176	11 473	80 098	66
Indonesia to LAX	13	67	46	40	527	135
Five Market Average			21.7			29.4

Having chosen the markets and having made computer runs of those markets with total tons and dollars by mode, it is necessary to look at each market by its principal commodity trade. Douglas has developed a simple but effective computer "cumulative listing" of all commodities in a region-to-region flow. This report arrays the commodities by average $/kg from high to lowest value. This output lists all air and surface dollars and kilos in the data base. The report is extremely useful in identifying commodity mix and trade imbalance by direction of flow. Each individual record is printed, and a cumulative total

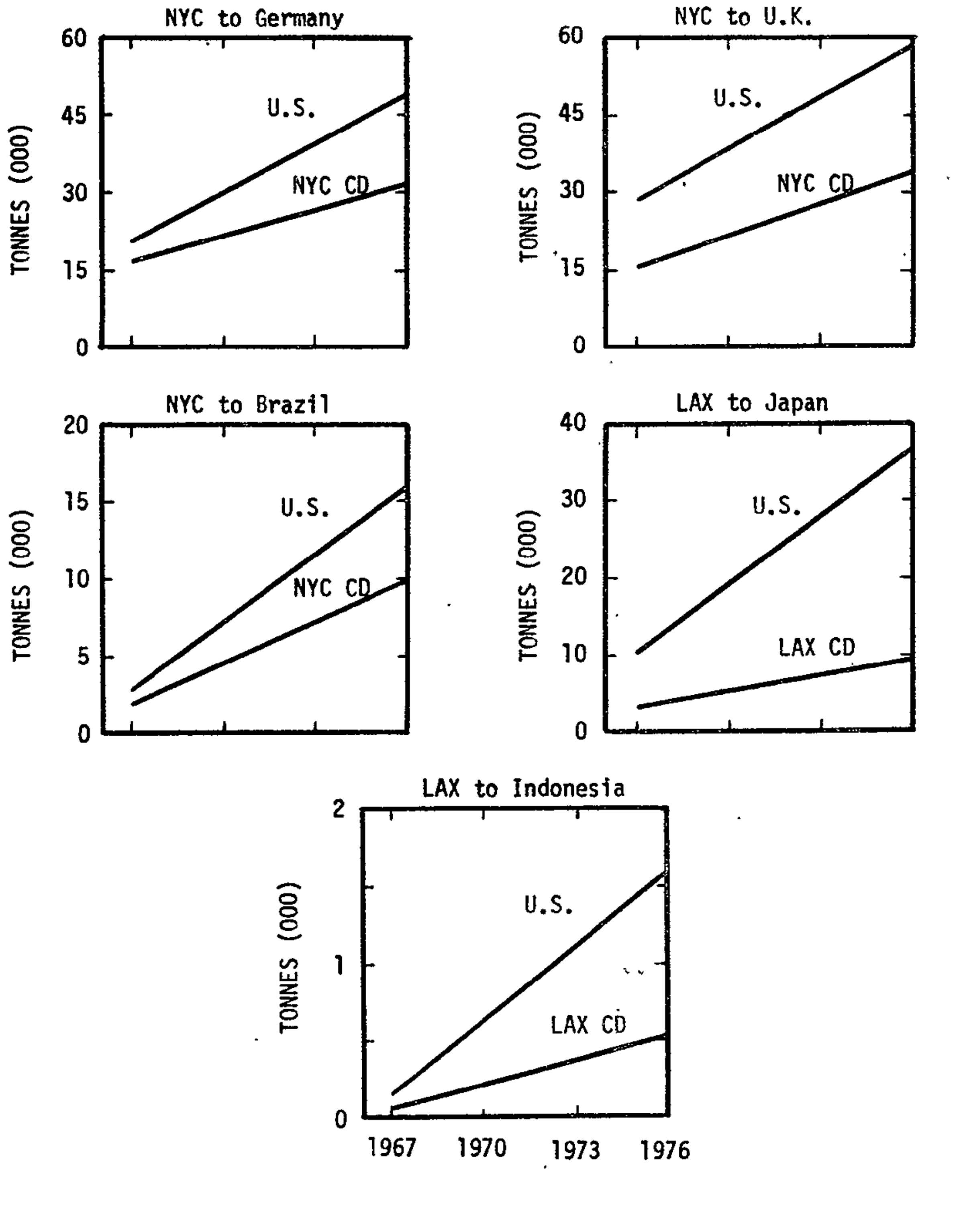

Figure 1-40. U.S. International Airfreight Markets - Growth in Export Air Tonnes Carried by Customs District and U.S. Total Customs District Air Tonnes (000)

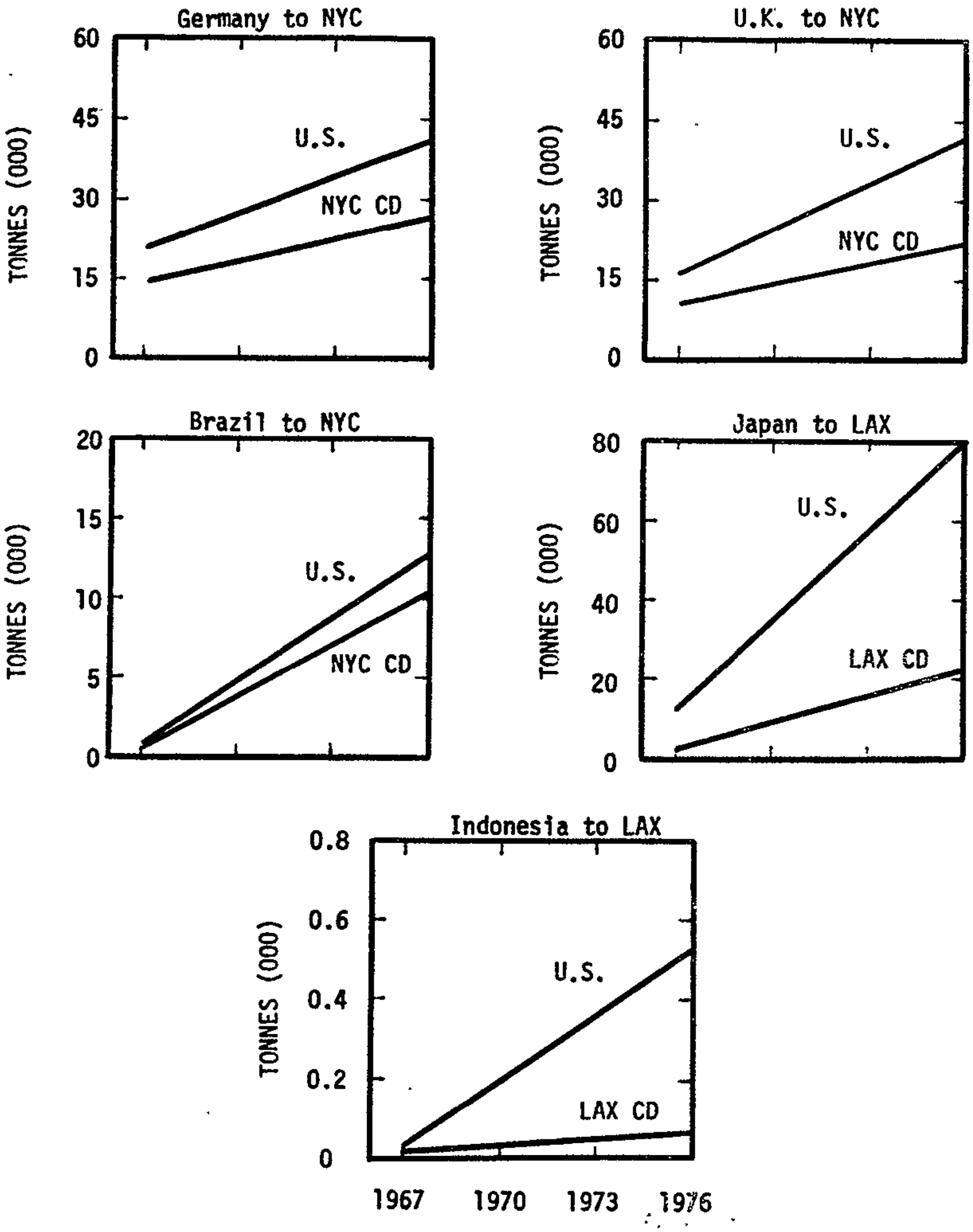

Figure 1-41. U.S. International Airfreight Markets - Growth in Import Air Tonnes Carried by Customs District and U.S. Total Customs District Air Tonnes (000)

TABLE 1-104

CUSTOMS DISTRICT

TRAFFIC CARRIED,
1972 - 1976
AIR TONNES

	1972	1973		1974		1975		1976	
	Tonnes	Tonnes	% Change	Tonnes	% Change	Tonnes	% Change	Tonnes	% Change
NYC - Germany	26 695	32 358	21	33 627	4	28 132	(16)	30 272	8
Germany - NYC	27 090	27 002	0	26 063	(3)	21 318	(18)	26 386	24
NYC-UK	33 480	44 850	34	47 237	5	36 745	(22)	34 542	(6)
UK - NYC	23 962	23 041	(4)	26 928	17	23 779	(12)	21 910	(8)
NYC - Brazil	5 948	8 921	50	12 568	41	9 527	(24)	9 927	4
Brazil - NYC	7 704	11 004	43	11 017	0	10 848	(2)	10 354	(4)
LAX - Japan	6 237	12 342	98	11 780	(4)	10 223	(13)	9 047	(11)
Japan - LAX	14 009	11 989	(14)	12 810	7	13 206	3	22 948	26
LAX - Indonesia	95	157	65	312	99	371	19	521	38
Indonesia - LAX	21	58	176	60	3	60	0	67	12
	45 241	171 722	18	182 402	6	154 209	(15)	165 965	8

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is maintained. More than 23 000 tonnes moved from NYC to West Germany by air mode in 1976 with a value of more than $8.15/kg. The report of sea flow is used to identify the more likely air potential product groups.

To gain further insight about specific commodity groups, (i.e., industries and products) both U.S. exports and imports were aggregated by commodity group on the computer. Table 1-105 is page 1 of a specialized commodity report sorted by highest air tonnes. This provides a priority shopping list of the top commodities which consistently generate the majority of air traffic. Table 1-106 is the same data sorted on highest percent air penetration. These two reports can be used jointly to perform preliminary market assessments by industry and product.

Particular airfreight markets seem to develop an identity and uniqueness of their own. For instance, the seasonality aspect of one market will vary markedly from another when a month-to-month profile is plotted. Figures 1-42 through 1-46 are plots of air tonnes as they varied from month to month during 1976 for all 10 U.S. international air markets. A good example of seasonal contrast is illustrated in Figure 1-43 which describes the NYC-to-UK and UK-to-NYC markets. It is evident that demand for capacity rose rapidly during late January in the NYC-to-UK market and continued through June at which time demand fell by almost 20 percent to rise again to a higher pattern for the fall season. The backhaul from the UK, by comparison, fluctuated between 10 percent and 15 percent and was quite consistent with exception of Christmas time when purchase demand is usually highest. Certainly, seasonal demand is one economic phenomenon that must be contended with if an air carrier is to operate successfully.

TABLE 1-105
AIR PENETRATION BY SITC

(SORTED BY HIGHEST AIR TONNES)

PAGE
YEAR TO DATE AS OF DEC 19,

CODE	COMMODITY	VESSEL VALUE ($)	VESSEL WEIGHT (TONNES)	AIR VALUE ($)	AIR WEIGHT (TONNES)	AIR/TOT (PERCENT)
93100	PERSONAL EFFECTS	402 549 791	276 334	883 494 862	51 237	15.8
85102	FOOTWEAR OF LEATHER	888 059 275	195 713	325 943 299	33 229	14.5
84112	WOMEN GIRLS INFANTS OUTER GARMENTS NOT KNITTED OR CROCHETED	400 803 775	56 430	306 255 335	24 780	30.5
84144	OUTER GARMENTS KNITTED CROCHETED NOT ELASTIC NOR RUBBERIZED	572 365 768	80 565	324 174 129	23 425	22.5
72499	OTHER TELECOM EQUIPMENT	805 928 368	95 293	472 465 587	21 821	18.6
84111	MEN BOYS OUTER GARMENTS NOT KNITTED OR CROCHETED	279 203 549	37 671	181 210 806	13 782	28.8
29272	FOLIAGE BRANCHES	5 983 298	5 640	23 127 709	13 256	70.2
72930	THERMIONIC, ETC. VALVES AND TUBES, PHOTOCELLS, TRANSISTORS	54 959 098	5 735	1 027 476 111	11 244	66.2
84143	UNDER GARMENTS KNITTED CROCHETED NOT ELASTIC NOR RUBBERIZED	367 380 763	48 403	120 977 552	10 188	17.4
71420	CALCULATING MACHINES, ACCOUNTING MACHINES AND SIMILAR MACHINES	185 742 418	15 751	139 659 573	9 241	37.0
84130	APPAREL AND CLOTHING ACCESSORIES OF LEATHER	134 130 868	16 252	161 619 124	8 143	33.4
29269	LIVE PLANTS NES	1 015 894	1 472	12 409 839	7 459	83.5
89442	ARCHERY EQUIPMENT BALLS NETS SKIS	183 972 113	45 987	60 198 292	7 047	13.3
72420	RADIO BROADCAST RECEIVERS	776 981 596	101 179	124 308 247	7 006	6.5
03130	CRUSTACEA AND MOLLUSCS, FRESH, CHILLED, FROZEN, SALTED OR DR	461 351 705	97 688	37 989 742	6 739	6.5
89300	ARTICLES OF ARTIFICIAL PLASTIC MATERIALS, N.E.S.	455 984 353	172 615	67 650 554	6 709	3.7
83100	TRAVEL GOODS, HANDBAGS AND SIMILAR ARTICLES	250 780 527	72 957	75 213 659	6 627	8.3
73280	MOTOR VEHICLE PARTS	1 185 967 671	563 760	21 472 671	6 335	1.1
72220	APPARATUS FOR MAKING AND BREAKING OR PROTECTING ELECTRICAL C	114 288 948	23 456	156 962 316	6 228	21.0
89111	GRAMOPHONES TAPE RECORDERS ETC	845 832 942	118 834	88 573 960	6 088	4.9
05460	OTHER FRESH VEGETABLES	17 303 020	41 721	3 000 948	5 673	12.0
84113	MEN BOYS UNDER GARMENTS NOT KNITTED OR CROCHETED	260 335 467	43 072	56 946 250	5 064	10.5
71150	INTERNAL COMBUSTION ENGINES, OTHER THAN FOR AIRCRAFT	450 910 662	152 320	192 281 129	4 763	3.0
72210	ELECTRIC POWER MACHINERY	180 806 687	81 184	54 269 744	4 240	5.0
61140	LEATHER OF OTHER BOVINE CATTLE AND EQUINE LEATHER	53 591 484	11 240	33 422 308	4 162	27.0
51200	ORGANIC CHEMICALS	936 979 618	1 400 422	130 133 555	4 131	0.3
89241	TRANSFERS	8 046 233	2 166	18 377 816	4 056	65 2
89423	TOYS NES	214 427 514	97 380	20 407 617	4 045	4.0
89424	INDOOR GAME EQUIPMENT	64 473 093	29 673	20 185 392	3 784	11.3
89720	IMITATION JEWELRY	41 241 101	7 874	70 612 962	3 563	31.2
03100	FISH, FRESH AND SIMPLY PRESERVED	5 456	1	15 209 977	3 538	100.0
71492	PARTS OF OFFICE MACHINERY NES	66 645 751	7 000	249 949 136	3 498	33 3
85101	FOOTWEAR OF RUBBER OR PLASTIC	340 275 825	124 410	21 374 045	3 461	2.7
71980	MACHINERY AND MECHANICAL APPLIANCES, N.E.S.	193 359 225	46 368	48 307 275	3 347	6.7
03110	FISH, FRESH, CHILLED OR FROZEN.	595 520 486	564 575	5 395 432	3 157	0.6
72505	ELECTRIC SPACE HEATING EQUIPMENT, ETC.	261 959 548	67 127	18 774 798	3 122	4.4
72994	ELECTRIC SOUND VISUAL SIGNALLING APPARATUS NES	19 357 804	2 969	63 508 413	2 942	49.8
72952	OTHER ELECTRICAL MEASURING AND CONTROLLING INSTRUMENTS AND A	61 067 906	5 514	150 214 248	2 684	32.7
89211	PRINTED BOOKS PAMPHLETS ETC	111 836 509	42 121	20 253 184	2 681	6.0
05195	TROPICAL FRUIT OTHER THAN BANANAS FRESH	4 613 150	24 574	582 784	2 637	9.7
86171	MEDICAL INSTRUMENTS AND APPLIANCES	27 335 254	5 024	69 535 043	2 578	33.9
86140	PHOTOGRAPHIC CAMERAS (OTHER THAN CINEMATOGRAPHIC)	92 133 920	2 625	161 678 430	2 539	49.2
84125	CORSETS SUSPENDERS GARTERS ET SIMILIA	23 947 686	2 424	31 671 633	2 521	51.0
65351	FABRICS WOVEN CONT. SYNTHETIC FIBRES EXC. PILE OR CHENILLE	132 265 134	18 295	35 392 908	2 504	12.0
89299	ADVERTISING CATALOGUES CHARTS TICKETS ETC	29 398 909	6 507	16 223 041	2 381	26.8
71921	PUMPS FOR LIQUIDS	104 356 350	24 019	28 974 583	2 327	8.8
01110	FRESH OR FROZEN BEEF	696 367 130	567 827	3 653 609	2 308	0.4
65220	COTTON FABRICS, WOVEN, OTHER THAN GREY (BLEACHED, DYED, MERC)	113 440 986	25 607	22 628 793	2 306	8.3
71510	MACHINE-TOOLS FOR WORKING METALS	273 395 357	233 533	16 641 295	2 257	1 0
71713	MACHINES AUXIL WEAVING KNITTING MACHINES	53 757 132	8 162	62 074 972	2 234	21.5

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TABLE 1-106
AIR PENETRATION BY SITC

(SORTED BY HIGHEST PERCENT AIR PENETRATION)

PAGE
YEAR TO DATE AS OF DEC 19,

CODE	COMMODITY	VESSEL VALUE ($)	VESSEL WEIGHT (TONNES)	AIR VALUE ($)	AIR WEIGHT (TONNES)	AIR/TOT (PERCENT)
00130	SWINE - LIVE	0	0	39 469	12	100.0
00140	POULTRY - LIVE	0	0	152 549	11	100.0
03100	FISH, FRESH AND SIMPLY PRESERVED	5 456	1	15 209 977	3 538	100.0
61194	PARCHMENT DRESSED LEATHER	0	0	147 019	2	100.0
66720	DIAMONDS (OTHER THAN INDUSTRIAL DIAMONDS), NOT SET OR STRUNG	8 660	0	129 610 928	3	100.0
68121	PLATINUM ETC UNWROUGHT PARTLY WORKED NOT ROLLED	0	0	269 392 059	90	100.0
89714	ARTICLES PEARLS PRECIOUS STONES	87 872	0	12 912 600	29	100.0
89961	HEARING AIDS	8 052	0	10 634 207	16	100.0
89991	ARTICLES MADE FROM GUT	691	0	893 575	64	100.0
00150	HORSES AND MULES - LIVE	12 123	6	21 807 266	814	99.3
89711	JEWELRY PRECIOUS METAL	215 352	2	154 333 383	217	99.1
86411	POCKET WATCHES WRIST WATCHES OTHER WATCHES	1 965 934	13	228 315 628	904	98.6
86413	WATCH MOVEMENTS ASSEMBLED	673 359	4	135 728 496	276	98.6
71142	JET AND GAS TURBINES FOR AIRCRAFT	309 384	12	93 222 817	692	98.3
65405	OTHER TULLE NET FABRICS LACE	28 885	1	1 635 457	50	98.0
00110	CATTLE - LIVE	76 525	9	3 999 327	335	97.4
94100	ANIMALS NES INCL ZOO ANIMALS DOGS AND CATS	80 382	17	5 402 438	435	96.2
86121	FRAMES FOR SPECTACLES ETC	1 306 859	48	78 256 493	1 078	95.7
61192	LEATHER GOAT KID SKINS	1 175 852	84	27 027 880	1 631	95.1
68111	SILVER UNWROUGHT PARTLY WORKED NOT ROLLED	7 810 348	61	112 594 928	829	93.1
86414	WATCH CASES PARTS THEREOF	2 332 914	64	55 460 727	792	92.5
84123	TIES BOW TIES CRAVATS	286 187	27	7 187 029	185	87.3
89962	ORTHOPAEDIC APPL ARTIF PARTS OF BODY AND FRACTURE APPL.	1 441 272	138	6 224 776	852	86.1
66740	SYNTHETIC PRECIOUS STONES NOT SET OR STRUNG	67 833	1	6 899 391	6	85.7
54150	HORMONES	173 608	15	30 307 747	83	84.7
29269	LIVE PLANTS NES	1 015 894	1472	12 409 839	7 459	83.5
86192	BALANCES	838 895	47	5 590 202	168	78.1
73410	AIRCRAFT	9 396 464	201	81 815 221	687	77.4
86300	DEVELOPED CINEMATOGRAPHIC FILM	1 067 008	102	16 070 617	343	77.1
65313	PILE CHENILLE FABRICS SILK	17 803	1	143 973	3	75.0
89292	PLANS DRAWINGS INDUSTRIAL COMMERCIAL PURPOSES NOT PRINTED	93 582	17	3 664 681	44	72.1
29272	FOLIAGE BRANCHES	5 983 298	5640	23 127 709	13 256	70.2
84201	ARTICLES OF FURSKINS	4 103 401	326	18 252 733	709	68.5
71430	STATISTICAL MACHINES, E.G., CALCULATING FROM PUNCHED CARDS O	24 128 017	812	95 538 659	1 756	68.4
89602	ORIGINAL ENGRAVINGS PRINTS AND LITHOGRAPHS	428 093	26	7 408 146	55	67.9
86194	TECHNICAL DEMONSTRATION MODELS	132 874	13	280 791	27	67.5
89143	MUSICAL INSTRUMENT STRINGS	573 800	40	761 355	83	67.5
12210	CIGARS AND CHEROOTS	6 656 971	572	12 792 855	1 145	66.7
66710	PEARLS, NOT SET OR STRUNG	1 066 787	4	9 794 910	8	66.7
65322	PILE CHENILLE FABRICS WOOL FINE ANIMAL HAIR	1 257 757	124	3 306 985	243	66.2
72930	THERMIONIC, ETC. VALVES AND TUBES, PHOTOCELLS, TRANSISTORS	54 959 098	5735	1 027 476 111	11 244	66.2
89241	TRANSFERS	8 046 233	2166	18 377 816	4 056	65.2
54199	OTHER PHARMACEUTICAL GOODS	955 507	51	2 090 617	94	64.8
61230	UPPERS, LEGS AND OTHER PREPARED PARTS OF FOOTWEAR OF ALL MATE	1 566 696	253	5 632 610	448	63.9
86429	CLOCK AND WATCH PARTS NES	3 420 132	338	54 653 309	599	63.9
89995	WIGS FALSE BEARDS SWITCHES ETC	133 305 507	1043	34 521 909	1 769	62.9
29197	NATURAL SPONGES	175 306	15	766 134	25	62.5
86112	OPTICAL ELEMENTS MOUNTED	28 309 934	720	70 279 284	1 196	62.4
29113	IVORY AND WASTE	235 818	14	582 303	23	62.2
84151	HEADGEAR OF FELT	550 611	32	1 256 684	42	56.8

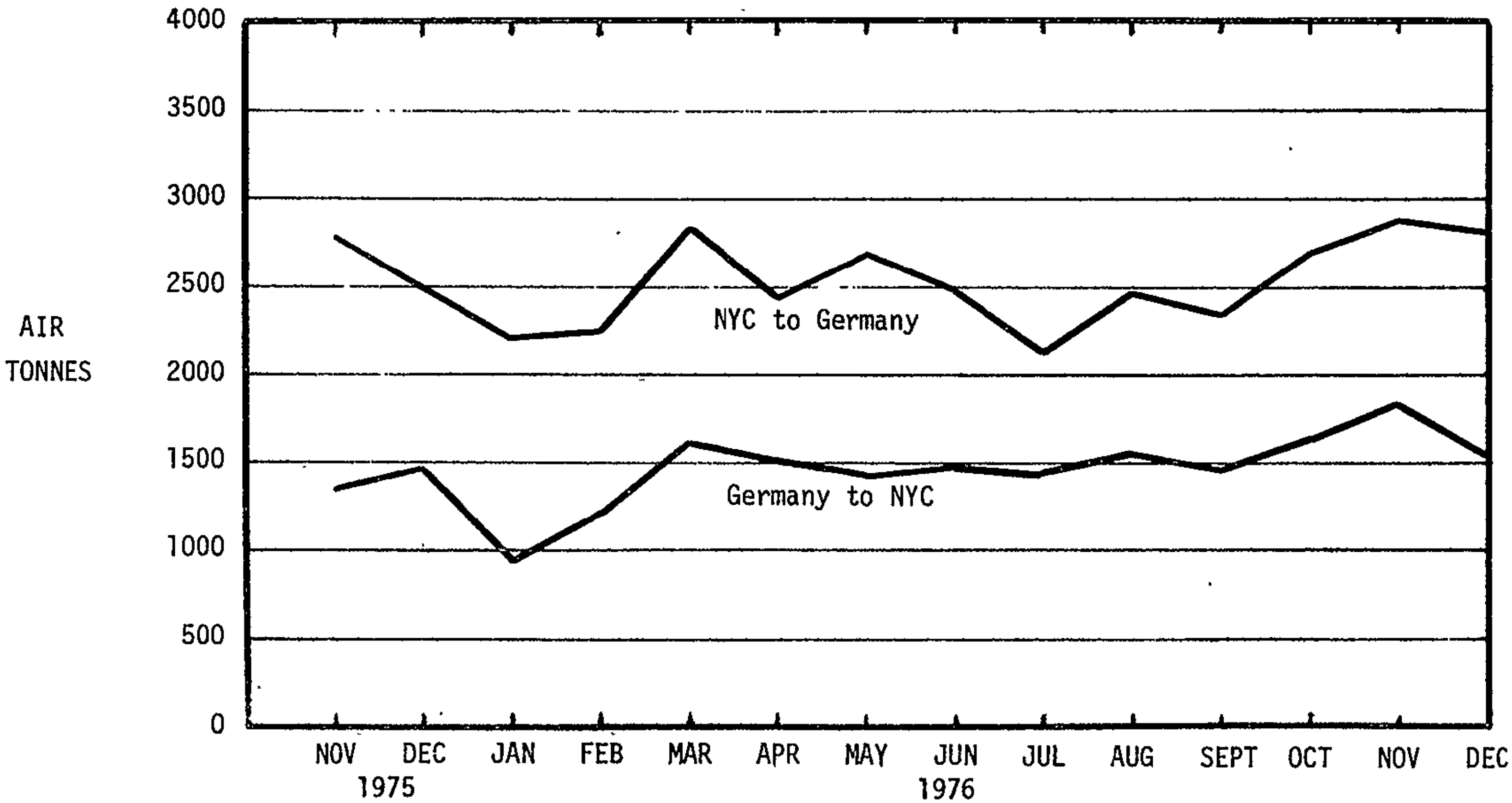

Figure 1-42. Seasonal Variation - Monthly Air Traffic - NYC and Germany

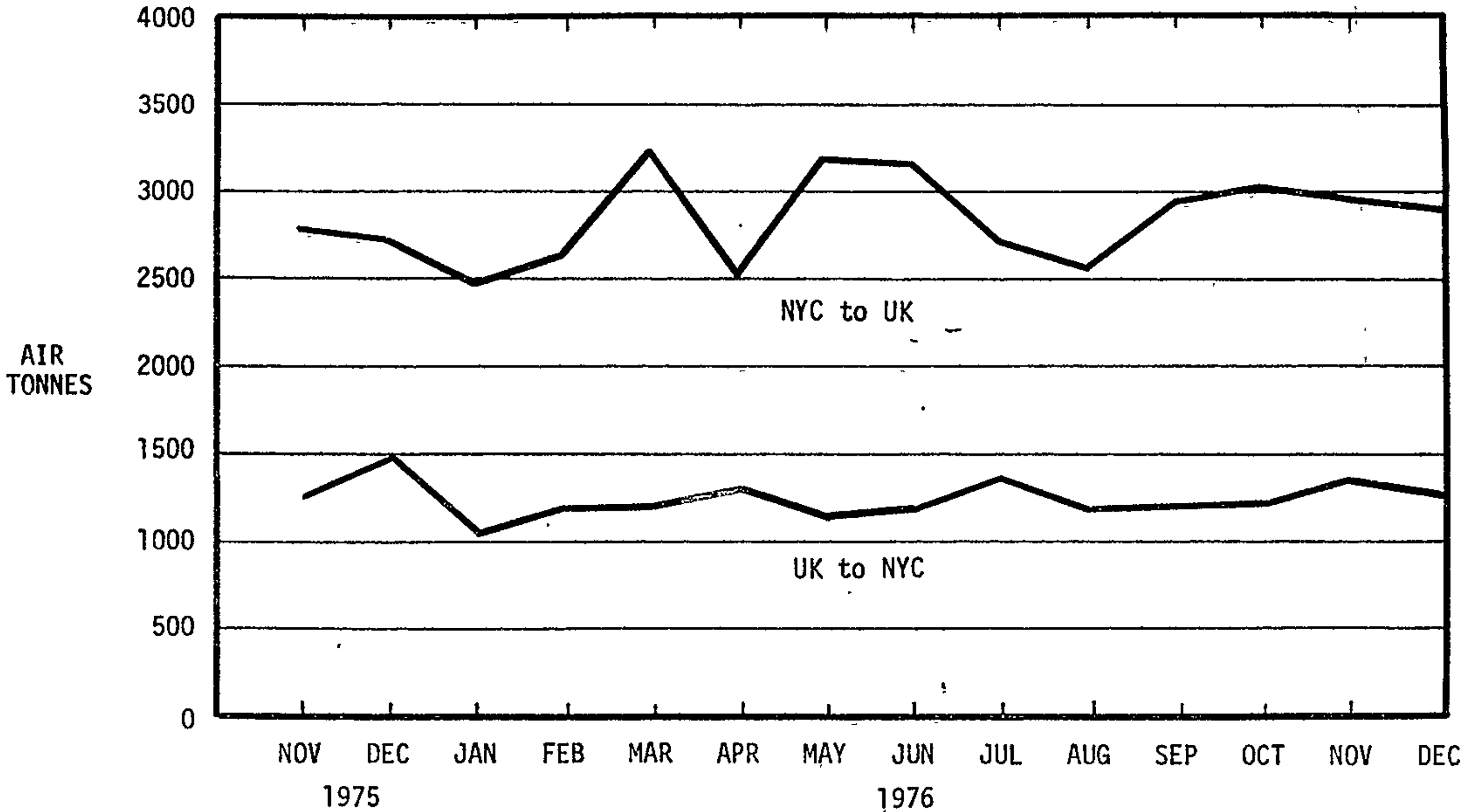

Figure 1-43. Seasonal Variation - Monthly Air Traffic - NYC and UK

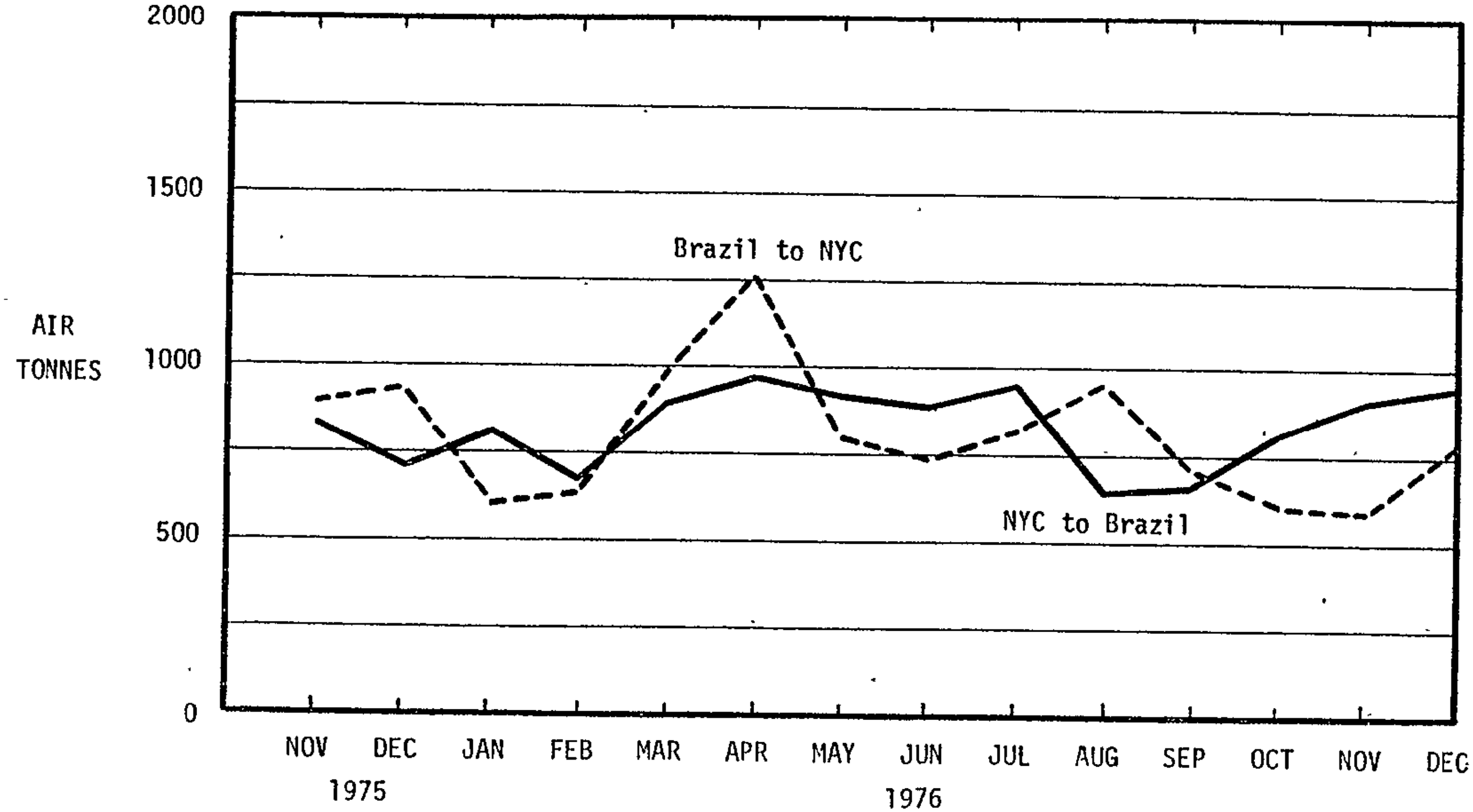

Figure 1-44. Seasonal Variation - Monthly Air Traffic - NYC and Brazil

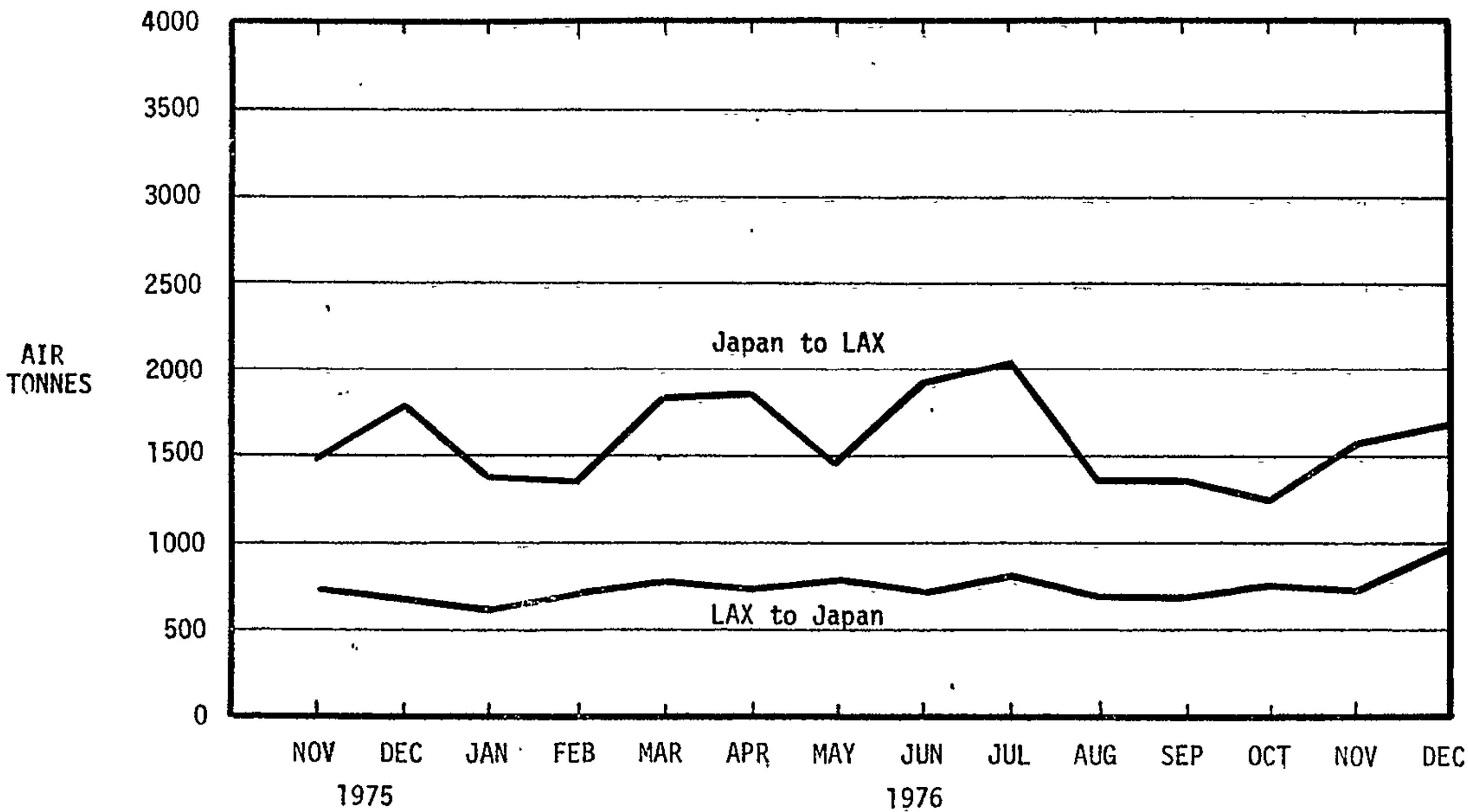

Figure 1-45. Seasonal Variation - Monthly Air Traffic - LAX and Japan

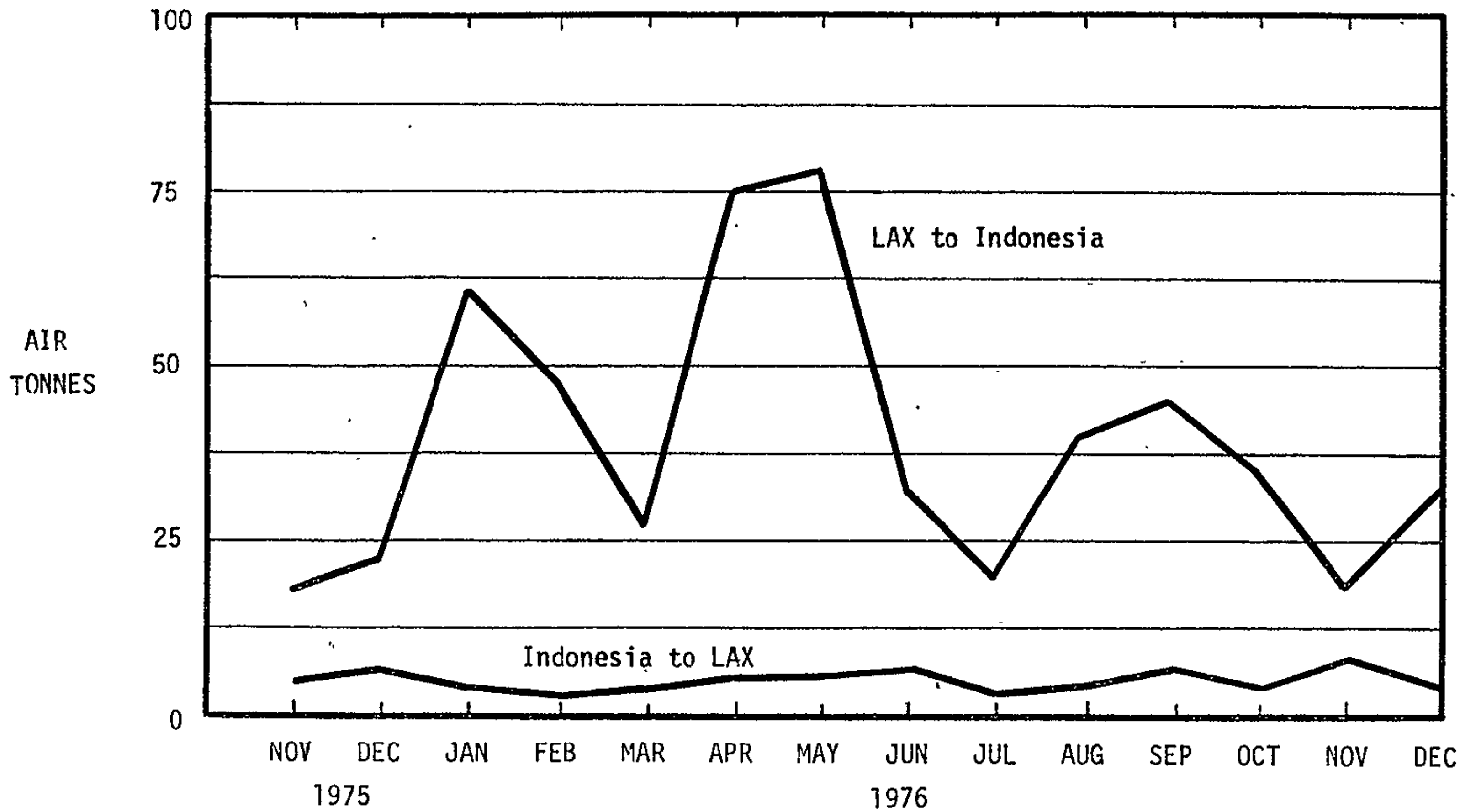

Figure 1-46. Seasonal Variation - Monthly Air Traffic - LAX and Indonesia

A preliminary evaluation has been performed for the 10 U.S. international airfreight markets, Tables 1-107 through 1-116. The NYC to Germany market for example, Table 1-107 lists 25 separate commodity flows of which 10 were by air and 15 were by vessel. They were selected from special annual data listings referred to prior as "cumulative listings." The data show that of over 271 000 tonnes moving through the Port of New York in 1976 to West Germany, over 30 000 tonnes or 11.2 percent actually went by air, which is rather high air penetration. The 25 commodities listed in the table are intended to relate a few of the high-value products currently moving by air, but more importantly indicate commodities of reasonably high value and of significant tonnage moving by sea, which represent likely air-eligible product groups.

To further characterize the 10 U.S. international airfreight markets, data from the Official Airline Guide (OAG) (Reference 1-5) was utilized to accomplish an analysis. A Douglas-developed cargo computer program inputs the passenger and cargo flight schedules by city-pair and aircraft type and outputs capacity tonnage offered.

Aircraft capacities are calculated upon the basis of the cubic capacity available and on assumed average density of the onboard loads. The following density assumptions apply to the aircraft type serving the selected markets:

Aircraft Type	Assumed Average Density
Freighter (AF)	163.4 kg/cu meter
Passenger (PAX)	
Bulk	115.3 kg/cu meter
LD3 Container	140.9 kg/cu meter
LD7 Container	163.4 kg/cu meter

Cargo capacity for passenger aircraft is based upon an average number of seats for each passenger aircraft type. Assuming 100-percent passenger load factor, 0.127 cubic meters of capacity are deducted for each seat and allocated

TABLE 1-107

U.S. INTERNATIONAL AIRFREIGHT MARKETS

NYC to Germany	6 186 Air Kilometers	
Air Tonnes	30 272	$ 1 030 900 000
Sea Tonnes	241 005	$ 664 100 000
	271 277	$ 1 695 000 000

Air % Tonnes - 11.2%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72930	Thermionic Valves	552	90.7	164.31
73492	Aircraft Parts	380	34.0	89.47
72499	Telecommunications Equipment	394	30.6	77.66
71430	Statistical Calculating Machines	620	45.0	72.58
72952	Electrical Measuring Devices	1 058	66.4	62.75
71492	Office Machine Parts	3 150	159.2	50.54
86199	Parts of Measuring Equipment	670	37.7	56.26
72210	Electrical Power Machinery	360	8.1	22.50
86169	Photo Equipment	2 410	38.1	15.80
73289	Auto Parts	388	4.1	10.57
	(sea)			
86246	Motion Picture Film	1 462	32.1	21.95
71160	Gas Turbines	803	10.4	12.95
86169	Photo Equipment	869	8.9	10.24
71510	Machine Tools	1 056	10.1	9.56
86243	Cloth, Sensitized	1 630	12.0	7.42
72210	Electrical Power Machinery	2 187	13.0	5.94
12220	Cigarettes	1 004	5.4	5.38
71915	Refrigerators	1 290	8.8	6.82
71931	Loading Machines	2 196	10.3	4.69
71150	Internal Combustion Engines	2 761	11.9	4.31
72930	Thermionic Valves	4 940	21.0	4.25
71932	Forklift Trucks	2 076	8.8	4.23
73289	Auto Parts	10 980	43.3	3.94
71842	Excavating Equipment	2 128	7.7	3.62
71220	Agricultural Machines	1 362	4.8	3.52
		46 726	722.5	15.46

TABLE 1-108

U.S. INTERNATIONAL AIRFREIGHT MARKETS

Germany to NYC	6 186 Air Kilometers	
Air Tonnes	26 386	$ 566 400 000
Sea Tonnes	655 852	$ 1 549 800 000
	682 238	$ 2 116 200 000

Air % Tonnes - 3.9%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
86134	Microscopes	158	10.5	66.46
86171	Medical Instruments	542	25.5	47.05
71430	Statistical Machinery	471	20.6	43.74
71713	Weaving Machinery	549	21.0	38.25
72620	X-Ray Apparatus	432	14.5	33.56
72220	Electrical Apparatus	466	11.3	24.25
81980	Mechanical Appliances	805	14.2	17.64
71921	Pumps	526	7.0	13.31
71510	Machine Tools	489	3.3	6.75
	(sea)			
72620	X-Ray Apparatus	2 351	44.5	18.93
71730	Sewing Machines	771	10.8	14.01
71923	Filtering Equipment	1 028	11.6	11.28
71410	Typewriters	5 442	61.1	11.23
89111	Gramophones	1 177	11.5	9.77
54110	Vitamins	1 057	8.5	8.04
71980	Mechanical Appliances	3 794	30.0	7.90
53101	Organic Dyestuffs	3 910	30.5	7.80
71921	Pumps	1 368	10.0	7.31
71829	Printing Machines	3 911	26.0	6.65
71712	Weaving Machines	2 249	13.9	6.18
73291	Motorcycle Parts	2 481	13.2	5.32
73210	Autos	65 320	278.0	4.26
		99 297	677.5	6.82

TABLE 1-109

U.S. INTERNATIONAL AIRFREIGHT MARKETS

NYC to UK	5 535 Air Kilometers		
	Air Tonnes	34 542	$ 1 002 200 000
	Sea Tonnes	498 183	$ 817 400 000
		532 725	$ 1 819 600 000
	Air % Tonnes - 6.5%		

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
73492	Aircraft Parts	560	49.3	88.04
72952	Electrical Measuring	734	45.6	62.12
71430	Statistical Machines	657	38.6	58.75
71492	Office Machine Parts	2 964	143.0	48.25
72220	Apparatus for Breaking	644	22.4	34.94
71980	Mechanical Appliances	836	20.5	24.52
72210	Electrical Power Machinery	529	9.7	18.34
86169	Photo Equipment	788	12.7	16.12
71842	Excavation Equipment	761	9.4	12.35
89120	Phonograph Records	603	7.0	11.61
89298	Prints and Photos	429	4.1	9.56
	(sea)			
51203	Sulfa Drugs	647	27.8	42.96
86246	Motion Picture Film	1 091	18.0	16.49
71510	Machine Tools	2 282	18.7	8.20
71922	Pumps	1 270	10.0	7.87
89120	Phonograph Records	1 292	10.0	7.74
71980	Mechanical Applicances	1 472	9.5	6.45
72210	Electrical Power Machinery	1 369	8.1	5.92
65351	Woven Fabrics	857	4.7	5.48
71150	Internal Combustion Engine	4 850	23.0	4.74
55229	Cotton Fabrics	1 950	8.6	4.41
71842	Excavating Equipment	3 943	16.7	4.24
73289	Auto Parts	9 801	37.2	3.80
72930	Thermionic Valves	8 507	31.0	3.64
89211	Book-pamphlets	6 077	19.7	3.24
		54 913	605.3	11.02

TABLE 1-110
U.S. INTERNATIONAL AIRFREIGHT MARKETS

UK to NYC	5 535 Air Kilometers	
Air Tonnes	21 910	$ 510 000 000
Sea Tonnes	882 362	$ 1 042 300 000
	904 272	$ 1 552 300 000
Air % Tonnes - 2.4%		

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
68111	Silver, Unwrought	150	22.6	150.66
73492	Aircraft Parts	168	18.9	112.50
71150	Engines	567	29.0	51.14
86414	Watch Parts	166	7.1	42.77
72952	Electrical Measuring	248	10.1	40.72
84144	Outer Garments	483	14.9	30.85
71713	Weaving Machines	501	11.2	22.35
85102	Leather Footwear	306	4.5	14.70
89211	Books	533	5.7	10.69
73280	Motor Vehicle Parts	407	2.4	5.90
	(sea)			
86241	Photo Plates	722	9.1	12.60
71953	Hand Tools	405	4.3	10.61
71410	Typewriters	1 056	8.9	8.43
71491	Duplicating Machines	1 082	8.0	7.40
66640	China-Porcelain	1 714	11.0	6.42
71980	Mechanical Appliances	1 588	8:6	5.41
71921	Pumps	1 215	6.3	5.19
89111	Tape Recorders	16 965	84.2	4.69
73210	Autos	15 233	68.8	4.52
89211	Books	8 716	38.4	4.40
89423	Toys	3 540	14.3	4.04
		56 765	388.3	6.84

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TABLE 1-111

U.S. INTERNATIONAL AIRFREIGHT MARKETS

NYC to Brazil	7 725 Air Kilometers	
Air Tonnes	9 927	$ 267 500 000
Sea Tonnes	143 390	$ 591 300 000
	153 317	$ 858 800 000

Air % Tonnes - 6.5%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
73492	Aircraft Parts	298	20.9	70.13
72930	Thermionic Valves	285	15.3	63.68
71492	Office Machine Parts	555	21.8	39.28
72499	Telecommunications Equipment	913	30.6	33.52
72220	Electrical Apparatus	248	5.2	20.96
73170	Parts R.R. Locomotive	524	5.2	9.92
73289	Auto Parts	694	6.3	9.07
	(sea)			
72952	Electrical Measuring	361	9.0	24.93
86246	Motion Picture Film	772	13.8	17.88
71954	Tool Parts	404	4.4	10.89
71992	Valves	716	7.3	10.19
86169	Photo Equipment	1 075	10.4	9.67
72220	Electrical Apparatus	2 423	22.0	9.08
71510	Machine Tools	7 865	65.2	8.29
73170	Parts R.R. Locomotive	3 350	25.8	7.70
71150	Internal Combustion Engines	3 396	22.6	6.65
72210	Electrical Power Machine	2 243	13.6	6.06
71922	Pumps	2 296	13.3	5.79
71980	Mechanical Appliances	4 926	27.7	5.62
73289	Auto Parts	4 231	23.0	5.44
71931	Load Machines	2 108	11.1	5.27
59920	Insecticides	3 095	15.3	4.94
		42 778	389.8	9.11

TABLE I-112

U.S. INTERNATIONAL AIRFREIGHT MARKETS

Brazil to NYC	7 725 Air Kilometers	
Air Tonnes	10 354	$ 116 300 000
Sea Tonnes	254 584	$ 513 400 000
	264 938	$ 629 700 000

Air % Tonnes - 3.9%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72941	Ignition Equipment	209	7.3	34.92
72420	Radios	246	8.1	32.93
84130	Clothing	284	5.1	17.96
83100	Travel Goods	772	7.5	9.72
61140	Leather	406	3.5	8.62
84111	Men's Clothing	345	2.4	6.96
85102	Footwear, Leather	6 108	40.5	6.63
	(sea)			
72420	Radios	124	2.6	20.96
03130	Crustacea	2 739	23.3	8.51
68710	Tin Alloys	1 282	9.2	7.18
85102	Footwear, Leather	12 241	70.9	5.79
07130	Coffee Extracts	14 702	72.7	4.95
		39 458	253.1	6.40

TABLE 1-113

U.S. INTERNATIONAL AIRFREIGHT MARKETS

LAX to Japan	8 808 Air Kilometers		
Air Tonnes	9 047	$	365 300 000
Sea Tonnes	2 324 730	$	1 039 700 000
	2 333 777	$	1 395 000 000

Air % Tonnes - 0.4%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72930	Thermionic Valves	195	46.1	236.41
73492	Aircraft Parts	510	53.2	104.31
72952	Electrical Measuring	264	21.5	81.44
71492	Office Machine Parts	387	24.1	62.27
71980	Machine/Mechanical Appliances	167	8.0	47.90
72220	Electrical Apparatus	184	8.5	46.19
86171	Medical Instruments	375	11.7	31.20
71842	Excavating Equipment	243	4.2	17.28
89120	Phonograph Records	197	3.2	16.24
89442	Archery Equipment	640	8.3	12.97
03130	Crustacea	468	3.5	7.48
	(sea)			
73492	Aircraft Parts	433	24.4	56.35
71492	Parts, Office Machinery	296	11.3	38.18
89442	Archery-Tennis Equipment	788	13.5	17.13
72210	Electrical Power Machines	430	5.9	13.72
71921	Pumps	663	6.3	9.50
72492	Microphones	1 725	13.6	7.88
89111	Tape Recorders	507	3.6	7.10
89330	Articles, Plastic	1 325	8.8	6.64
03130	Crustacea	4 694	28.5	6.07
71842	Excavating Equipment	3 688	21.8	5.91
		18 179	330.0	18.15

TABLE 1-114

U.S. INTERNATIONAL AIRFREIGHT MARKETS

Japan to LAX	8 808 Air Kilometers	
Air Tonnes	22 948	$ 502 000 000
Sea Tonnes	2 426 708	$ 4 098 300 000
	2 449 656	$ 4 600 300 000

Air % Tonnes - 1%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
86411	Watches	122	47.0	385.20
86140	Cameras	625	37.3	59.68
86112	Optical Elements	296	16.4	55.41
72930	Thermionic Valves	192	7.4	38.54
71492	Parts, Office Machine	204	7.3	35.78
72220	Apparatus, Breaking	448	12.0	26.79
72499	Telecommunications Equipment	7 077	152.5	21.54
89111	Gramophones	1 800	30.6	17.00
72420	Radios	1 229	20.3	16.51
71420	Calculating Machine	1 677	25.4	15.15
89424	Indoor Game Equipment	688	3.8	5.52
73280	Motor Vehicle Parts	438	2.3	5.25
	(sea)			
86140	Cameras	640	30.6	47.81
89120	Phonograph Records	984	20.0	20.32
71420	Calculating Machine	3 949	59.4	15.04
72499	Telecommunications Equipment	26 208	281.5	10.74
71491	Duplicating Machines	3 168	33.8	10.67
89111	Gramophones	38 618	358.6	9.29
72420	Radios	23 372	206.5	8.84
72410	TV Receivers	31 122	238.2	7.65
84144	Knitted Garments	3 302	24.5	7.42
71730	Sewing Machines	7 778	42.9	5.52
73292	Motorcycle Parts	6 272	32.2	5.13
72492	Microphones	17 805	78.9	4.43
73291	Motorcycle Parts	48 506	199.3	4.11
72505	Electric Heating Equipment	17 936	59.4	3.31
		244 456	2 028.1	8.29

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TABLE 1-115

U.S. INTERNATIONAL AIRFREIGHT MARKETS

LAX to Indonesia	14 440 Air Kilometers		
Air Tonnes	512	$	33 500 000
Sea Tonnes	53 437	$	83 900 000
	53 949	$	127 400 000

Air % Tonnes - 1%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
72499	Telecommunications Equipment	131	18.8	143.51
71842	Excavating Equipment	52	0.1	1.92
58110	Plaster Rolls	45	0.1	2.22
	(sea)			
71992	Taps, Valves, Etc.	258	3.1	12.01
71921	Pumps	385	4.4	11.42
71980	Machinery	139	1.5	10.79
67850	Pipe Fittings	472	3.6	7.63
72210	Electrical Power Machinery	382	2.8	7.33
71842	Excavating Equipment	1 154	7.9	6.85
71150	Internal Combustion Engines	174	1.0	5.75
67820	Iron Pipe	1 083	4.4	4.06
73202	Trucks	1 118	3.7	3.31
71919	Heating-Cooling Equipment	868	2.7	3.11
71923	Filter Equipment	706	1.8	2.55
		6 967	55.9	8.02

TABLE 1-116

U.S. INTERNATIONAL AIRFREIGHT MARKETS

Indonesia to LAX	14 440	Air Kilometers
Air Tonnes	67	$ 1 000 000
Sea Tonnes	13 310 442	$ 1 282 500 000

Air % Tonnes - 0%

SITC	Commodities	Tonnes	$ 10^6	$/Kg
	(air)			
93100	Personal Effects	9	0.5	55.50
03100	Fish	32	0.2	6.25
	(sea)			
03130	Crustacea	267	1.5	5.62
03202	Mollusks	292	0.9	3.08
07524	Nutmeg	182	0.3	1.65
07110	Coffee	3 730	6.6	1.77
		4 512	10.0	2.22

to passenger baggage. The residual volume is saleable capacity available for cargo. Freighter aircraft capacities are based upon available palletized main deck volume at 163.4 kg/cubic meter and applicable container or bulk densities for the lower holds.

With regard to capacity offered, wide-body passenger aircraft were serving all markets during the 1972 to 1977 time period. DC-8Fs, B747Fs and B707s were the principal freighter aircraft to serve these markets. A series of tabulations was prepared which compares reported traffic with service offered. Tables 1-117 through 1-120 enumerate, for the 10 U.S. international airfreight markets, the aircraft frequencies and capacity in tonnes offered in passenger service, all-freight services, and a summary of all services offered. Figures 1-47 through 1-56 depict graphically the percent change and disparity between capacity offered and capacity utilized.

In most of the case study markets, the facts indicate that traffic growth has been nominal, and some even show a decline over the 1972 - 1977 time period. However, the combination of the 1973 increase in fuel prices and the economic recession during 1974 had strong impact on deterioration in traffic carried and services offered. Some recovery and growth was experienced in the Pacific and South American markets, but with exception of those markets served by the B747F, a decline in all-freighter services appears to have occurred.

TABLE 1-117

U.S. INT'L AIRFREIGHT MARKETS
WEEKLY FREQUENCIES - PASSENGER AND ALL FREIGHTER
SERVICES FOR SELECTED MARKETS - 1972-1977 (AUGUST)

City Pair	1972		1973		1974		1975		1976		1977	
	PAX	AF	PAX	AF	PAX	AF	PAX	AF	PAX	AF	PAX	AF
FRA-NYC	49	37	54	37	45	41	34	32	41	25	41	23
NYC-FRA	54	28	53	32	45	33	34	34	37	25	37	23
LAX-JKT	3	-	4	-	4	-	3	-	1	-	1	-
JKT-LAX	4	-	5	-	3	-	3	-	1	-	1	-
LAX-TYO	37	24	46	15	42	16	44	18	41	20	38	19
TYO-LAX	44	20	46	24	42	17	44	16	41	11	38	15
LON-NYC	113	30	120	31	88	35	81	39	88	29	88	29
NYC-LON	113	31	118	33	91	35	80	35	85	22	84	22
NYC-RIO	27	7	29	6	27	9	18	3	17	7	17	9
RIO-NYC	20	5	23	3	30	7	19	7	17	9	17	7

TABLE 1-118

U.S. INT'L AIRFREIGHT MARKETS
WEEKLY CAPACITY OFFERED - PASSENGER SERVICES
1972 - 1977

City Pair	Tonnes/ Date and percent change										
	8/72	8/73	%	8/74	%	8/75	%	8/76	%	8/77	%
FRA-NYC	457.6	540.8	18	448.2	(17)	385.8	(14)	476.5	24	476.5	-
NYC-FRA	539.0	537.4	0	448.2	(16)	395.0	(12)	462.8	17	453.6	(2)
LAX-JKT	12.1	13.8	14	13.8	0	10.3	(25)	3.4	(67)	3.4	0
JKT-LAX	14.6	17.2	18	10.3	(40)	10.3	0	3.4	(67)	3.4	0
LAX-TYO	384.0	515.9	34	502.1	(3)	516.9	3	450.5	(13)	424.4	(6)
TYO-LAX	472.3	515.9	9	502.1	(3)	516.9	3	450.5	(13)	424.4	(6)
LON-NYC	990.4	1 048.4	6	788.8	(25)	747.3	(5)	828.8	11	849.1	3
NYC-LON	981.2	965.1	(2)	808.3	(16)	734.7	(9)	798.4	9	798.7	0
NYC-RIO	92.8	99.7	7	144.1	44	104.0	(28)	100.5	(3)	100.5	0
RIO-NYC	66.9	77.2	15	152.5	98	106.5	(30)	100.5	(6)	100.5	0

TABLE 1-119

U.S. INT'L AIRFREIGHT MARKETS
WEEKLY CAPACITY OFFERED - ALL FREIGHT SERVICES
1972-1977

City Pair	Tonnes/ Date and percent change									
	8/72	8/73	%	8/74	%	8/75	%	8/76	%	8/77	%
FRA-NYC	1 496.8	1 502.4	4	1 629.8	8	1 790.4	10	1 796.8	4	2 028.8	13
NYC-FRA	1 214.3	1 330.6	10	1 363.9	3	1 856.8	36	1 796.8	(3)	2 028.8	13
LAX-JKT	-	-		-		-		-		-	-
JKT-LAX	-	-		-		-		-		-	-
LAX-TYO	1 270 7	485.4	(62)	541.3	12	589.0	9	638.8	8	1 035.7	62
TYO-LAX	740.4	766.8	4	503.9	(34)	528.1	5	384.2	(27)	799.0	108
LON-NYC	930.4	958.1	3	1 091.1	14	1 533.6	41	1 355.1	(12)	1 653.6	22
NYC-LON	952.6	1 024.6	8	1 091.1	7	1 395.1	28	1 065.0	(24)	1 076.1	1
NYC-RIO	232.7	166.2	(29)	299.2	80	299.7	0	232.7	(22)	414.1	78
RIO-NYC	166.2	166.5	0	232.7	40	290.1	25	414.1	42	232.7	(44)

TABLE 1-120

U.S. INT'L AIRFREIGHT MARKETS
WEEKLY CAPACITY OFFERED - TOTAL SERVICES
1972 - 1977

City Pair	Tonnes/ Date and percent change										
	8/72	8/73	%	8/74	%	8/75	%	8/76	%	8/77	%
FRA-NYC	1 954.4	2 043.2	5	2 078.0	2	2 176.2	5	2 273.3	4	2 505.3	10
NYC-FRA	1 753.3	1 868.0	6	1 812.1	(3)	2 251.8	24	2 259.6	1	2 482.5	10
LAX-JKT	12.1	13.8	14	13.8	0	10.3	(25)	3.4	(67)	3.4	0
JKT-LAX	14.6	17.2	18	10.3	(40)	10.3	0	3.4	(67)	3.4	0
LAX-TYO	1 654.7	1 001.3	(40)	1 043.4	4	1 105.9	6	1 089.3	(3)	1 460.1	34
TYO-LAX	1 212.7	1 282.7	6	1 006.0	(22)	1 045.0	4	834.7	(20)	1 223.3	46
LON-NYC	1 920.8	2 006.5	4	1 879.9	(6)	2 280.9	21	2 183.9	(4)	2 502.7	15
NYC-LON	1 933.8	1 989.7	3	1 899.4	(4)	2 129.8	12	1 863.4	(12)	1 874.8	1
NYC-RIO	325.5	265.9	(18)	443.3	67	403.7	(9)	333.2	(17)	514.6	54
RIO-NYC	233.1	143.7	(38)	385.2	168	396.6	3	514.6	30	333.2	(35)

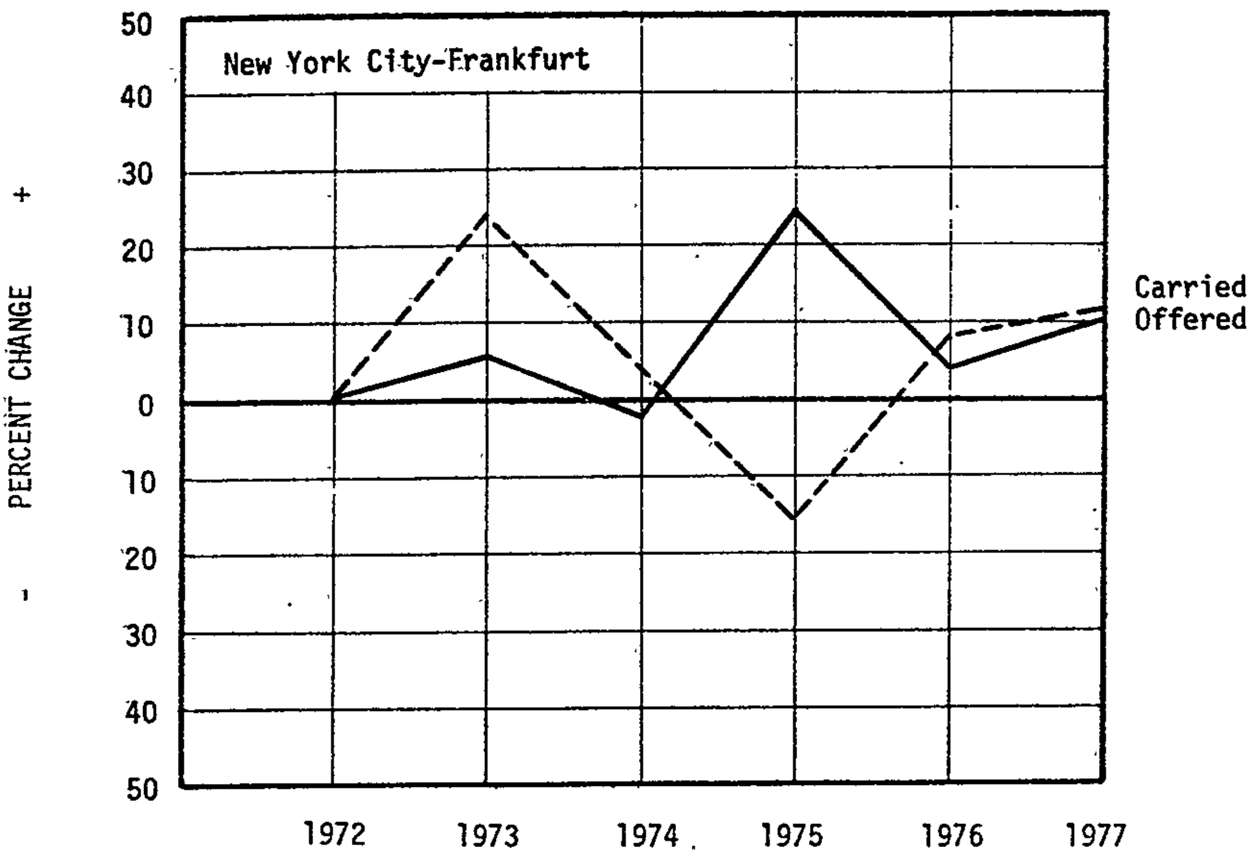

Figure 1-47. Total Air Cargo Service - Percent Change in Capacity Offered vs Tonnes Carried, 1972-1977 - NYC to Frankfurt

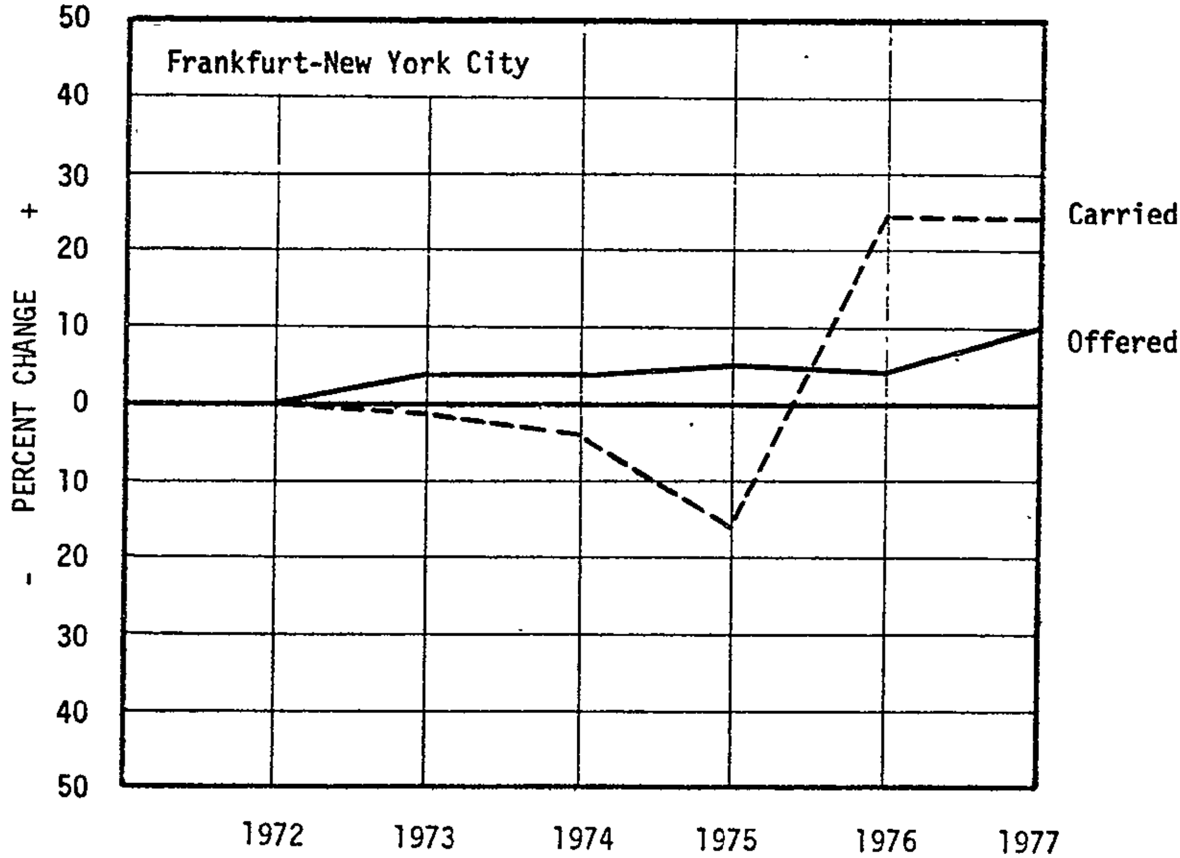

Figure 1-48. Total Air Cargo Service - Percent Change in Capacity Offered vs Tonnes Carried, 1972-1977 - Frankfurt to NYC

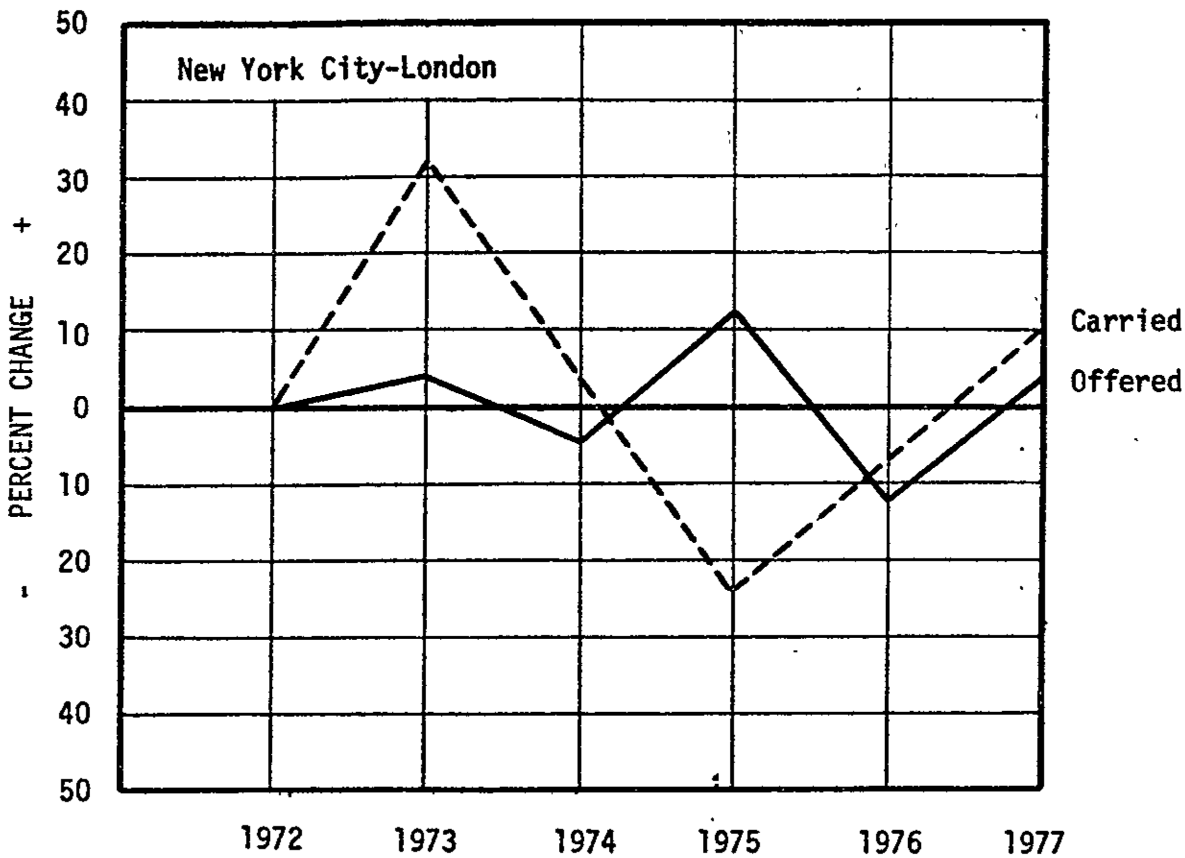

Figure 1-49. Total Air Cargo Service - Percent Change in Capacity Offered vs Tonnes Carried, 1972-1977 - NYC to London

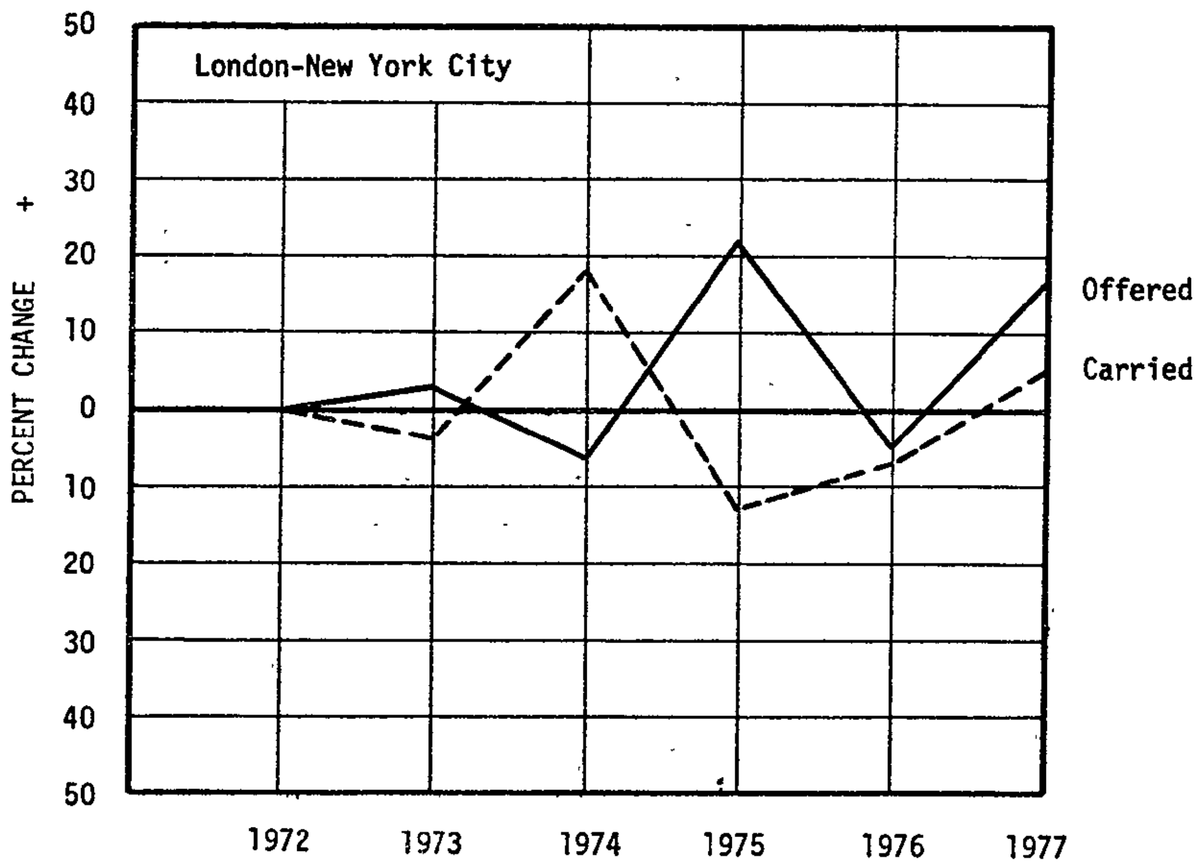

Figure 1-50. Total Air Cargo Service - Percent Change in Capacity Offered vs Tonnes Carried, 1972-1977 - London to NYC

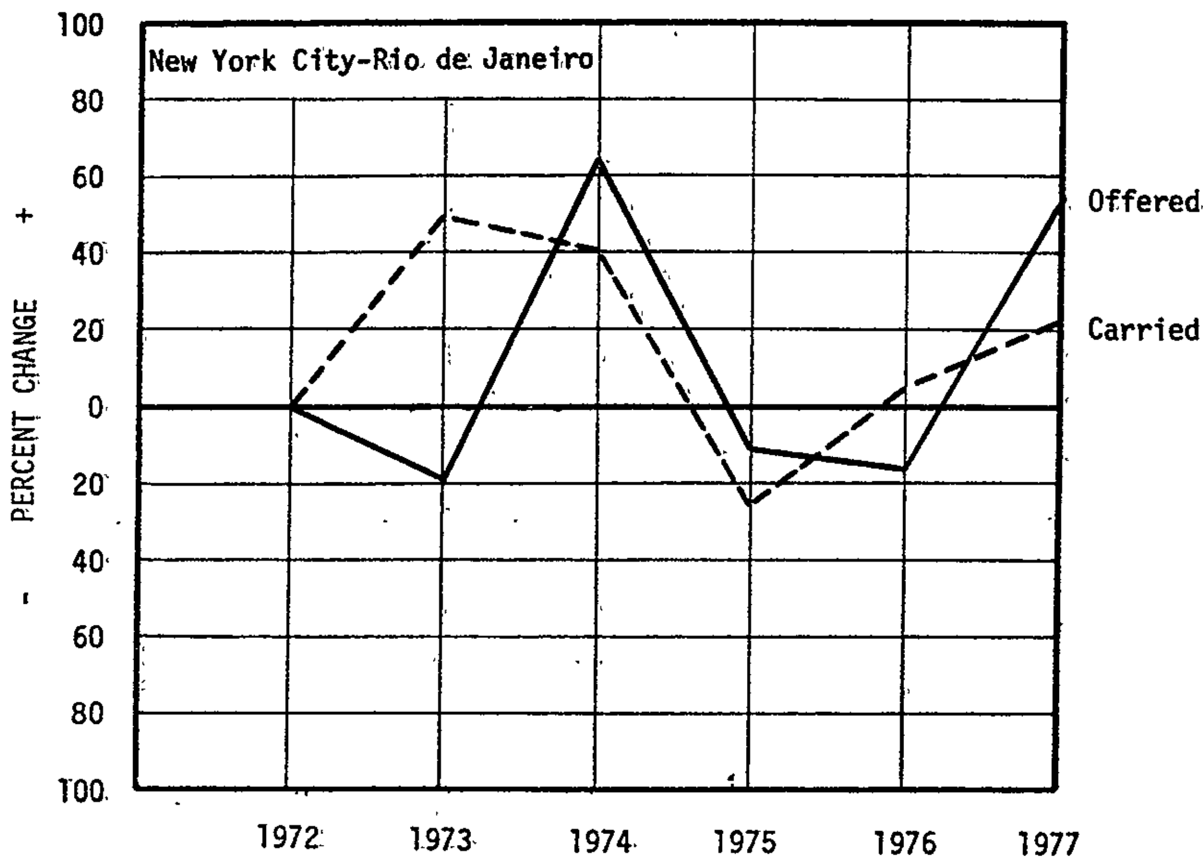

Figure 1-51. Total Air Cargo Service - Percent Change in Capacity Offered vs Tonnes Carried, 1972-1977 - NYC to Rio de Janeiro

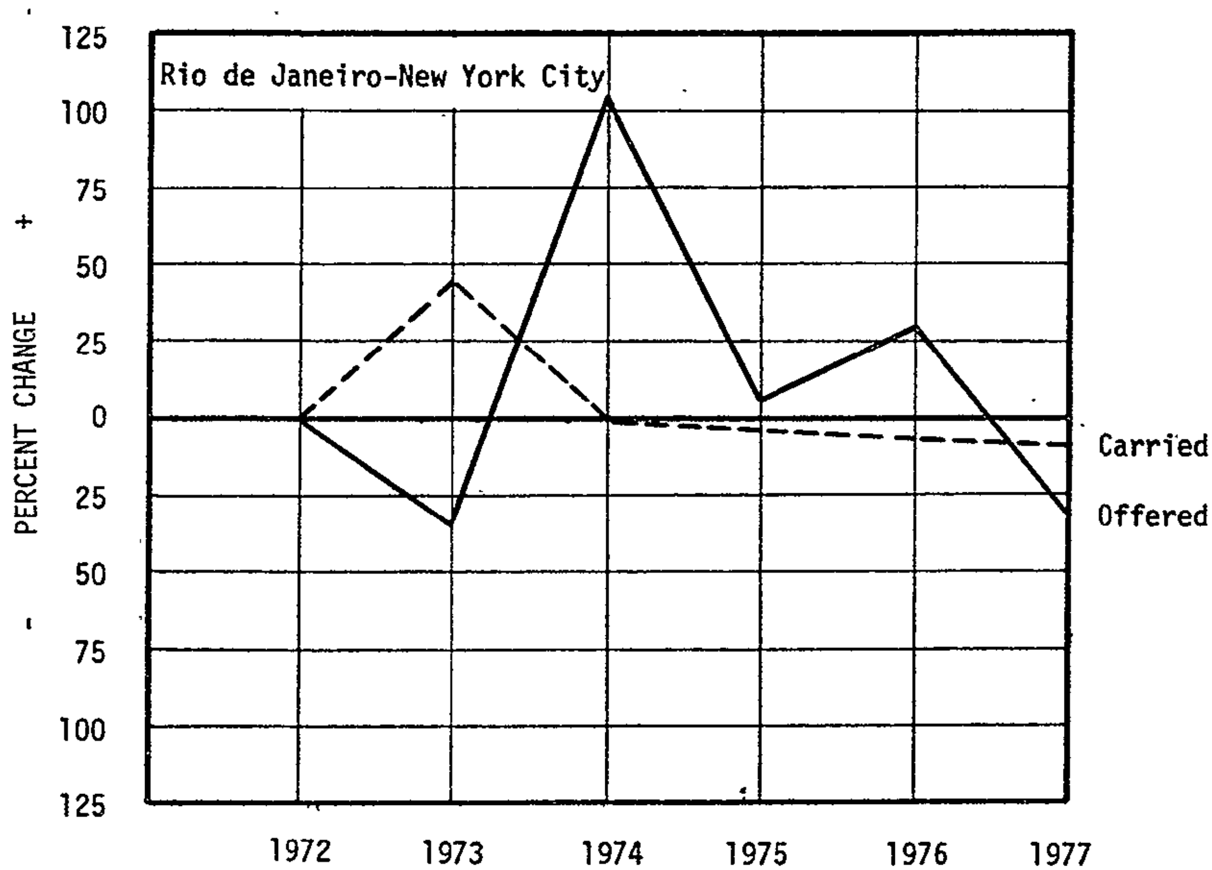

Figure 1-52. Total Air Cargo Service - Percent Change in Capacity Offered vs Tonnes Carried, 1972-1977 - Rio de Janeiro to NYC

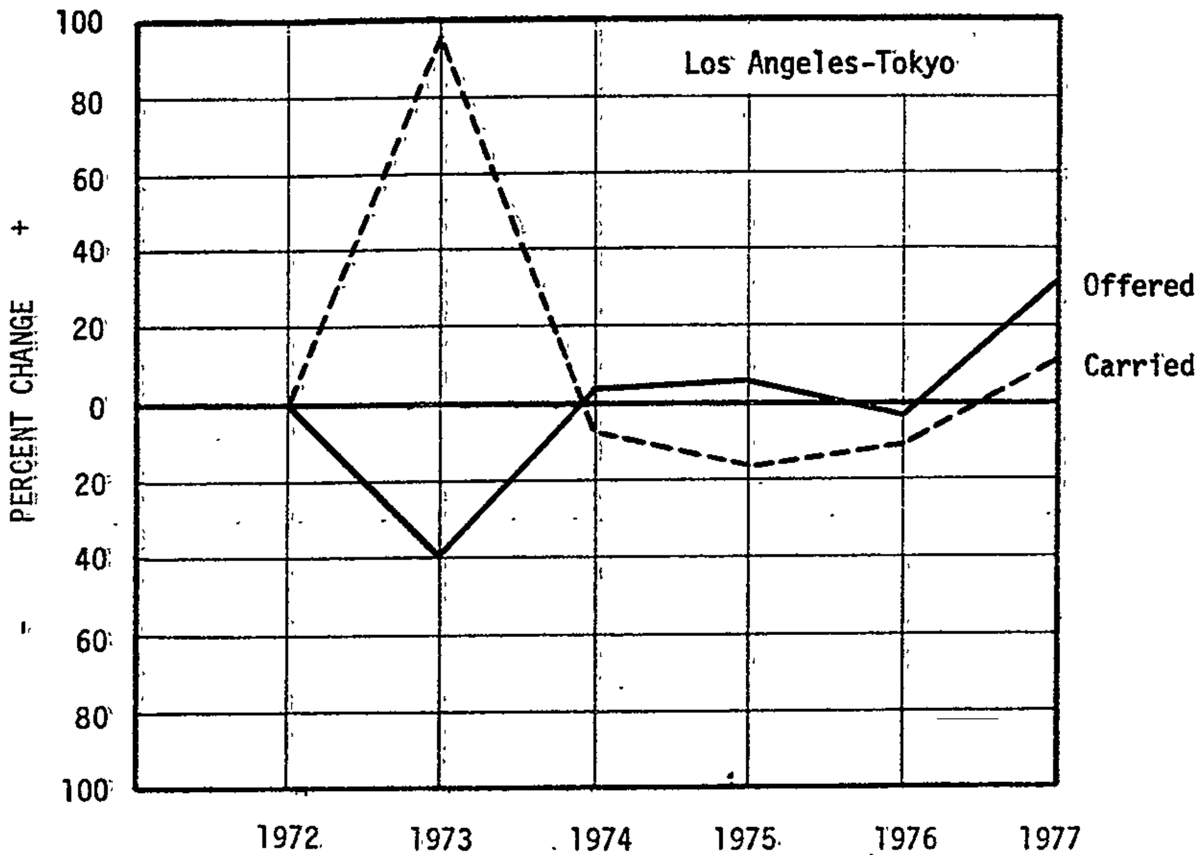

Figure 1-53. Total Air Cargo Service - Percent Change in Capacity Offered vs Tonnes Carried, 1972-1977 - LAX to Tokyo

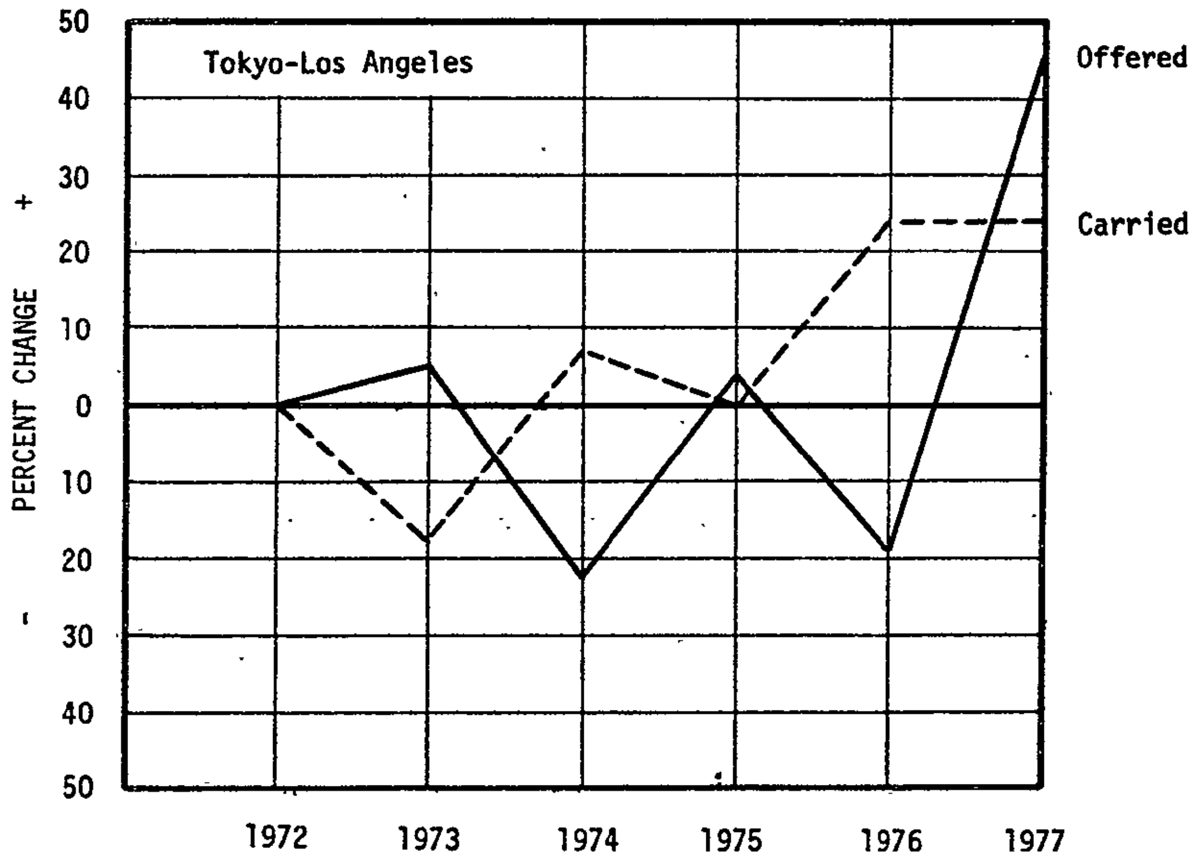

Figure 1-54. Total Air Cargo Service - Percent Change in Capacity Offered vs Tonnes Carried, 1972-1977 - Tokyo to LAX

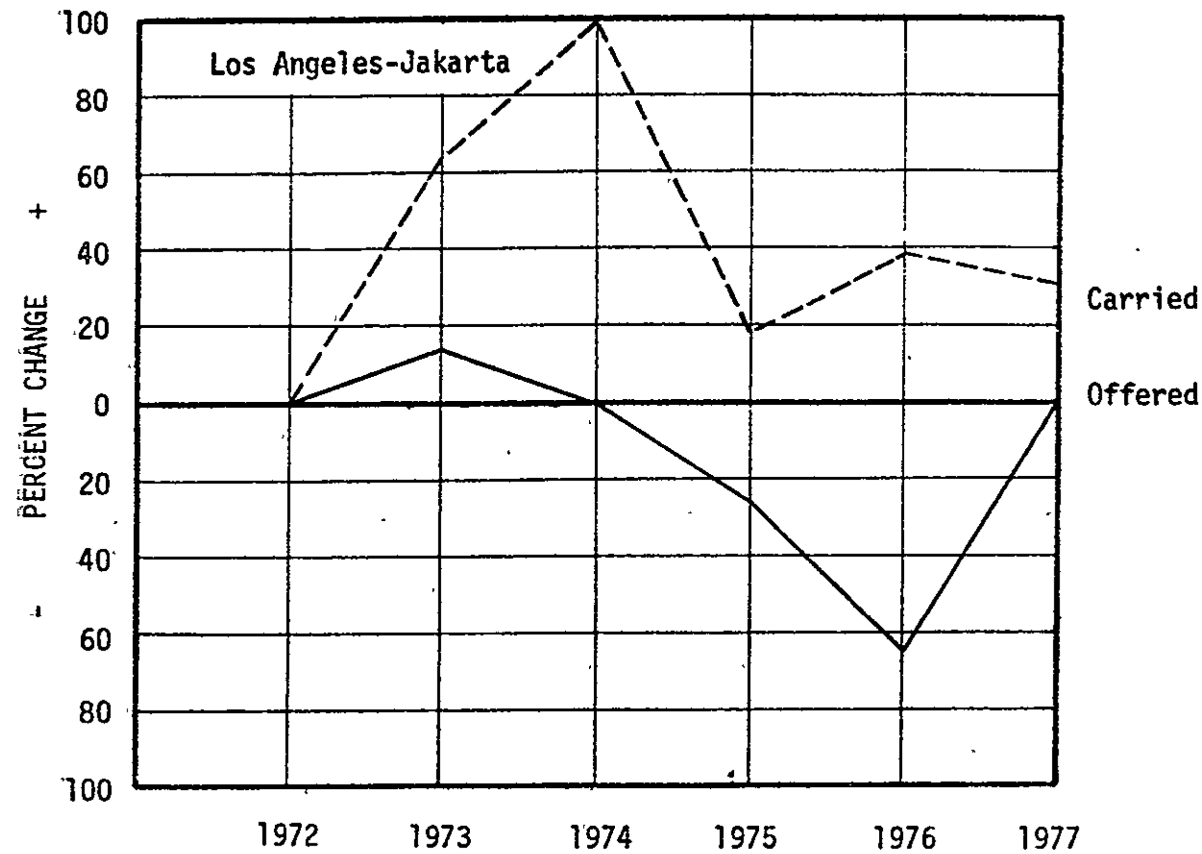

Figure 1-55. Total Air Cargo Service - Percent Change in Capacity Offered vs Tonnes Carried, 1972-1977 - LAX to Jakarta

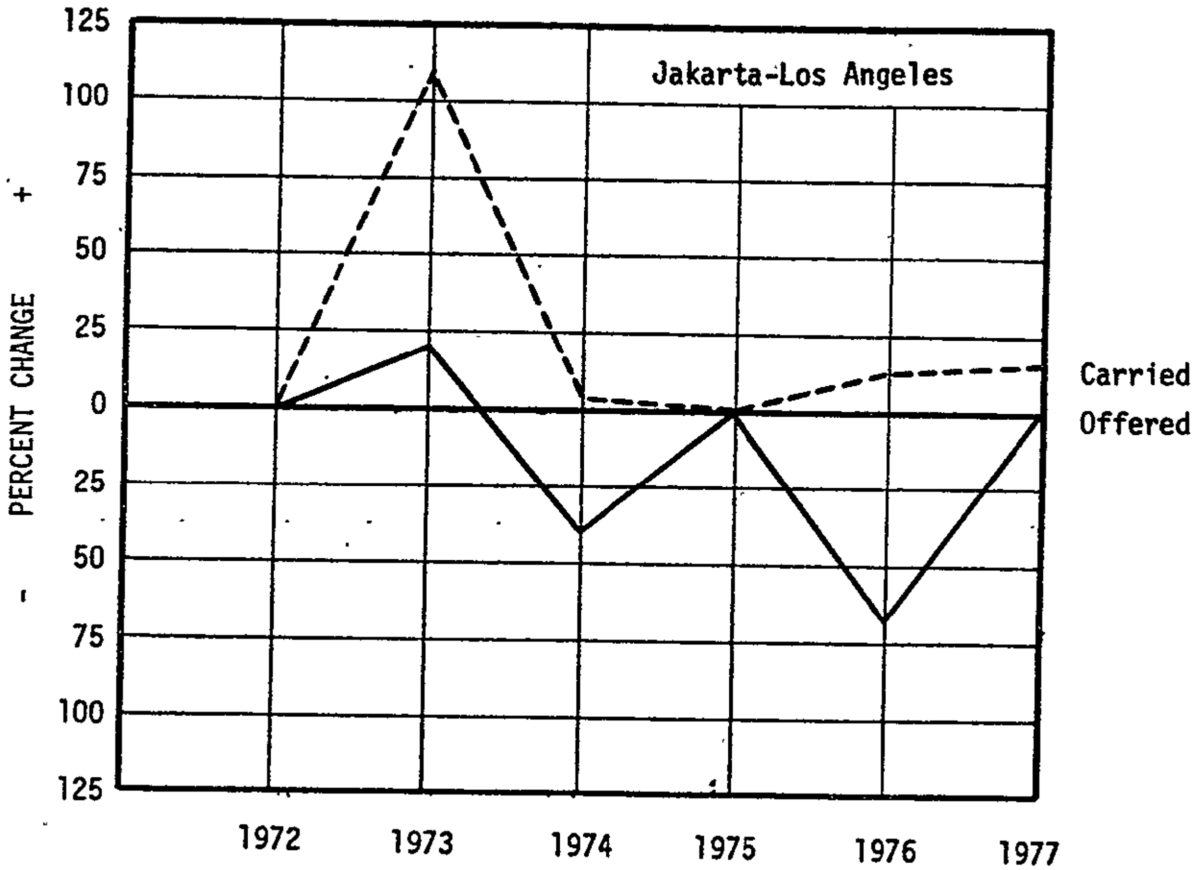

Figure 1-56. Total Air Cargo Service - Percent Change in Capacity Offered vs Tonnes Carried, 1972-1977 - Jakarta to LAX

Foreign commodity networks. - The foreign commodity networks selected are intended to be representative of the primary trade channels across the world, excluding the United States. Figure 1-57 shows the basic data flow for foreign commodity networks. International trade over the world has been increasing at a somewhat higher rate than average GNP growth. Real GNP average growth for major industrialized countries base slowed to 4.2 percent rate for the time period from 1969 through 1975. This compared to a real 9.0 percent trade growth rate for developed market economies around the world over the same time period.

The IMF 1975 Annual Direction of Trade (Reference 1-27) was utilized to determine the 25 top industrialized nations for total U.S. dollar exports and imports. This list was then reduced to 20 nations based on geographical location and economic growth potential. Fourteen representative countries were finally selected on the criteria of industrialization and trading capability. They are listed below.

FOREIGN COMMODITY FLOWS
IMF TRADE $ BIL.-1975 TO WORLD

Country	Export	Import
UK	48.2	44.4
Italy	35.5	36.0
Japan	50.5	55.6
South Africa	7.5	6.5
Hong Kong	6.7	5.9
Germany	70.0	75.0
Morocco	2.4	1.8
Australia	9.4	11.0
Iran	13.1	10.4
Nigeria	5.2	6.0
Brazil	11.6	9.2
Indonesia	5.0	4.7
Bolivia	0.6	0.5
Venezuela	5.0	5.4

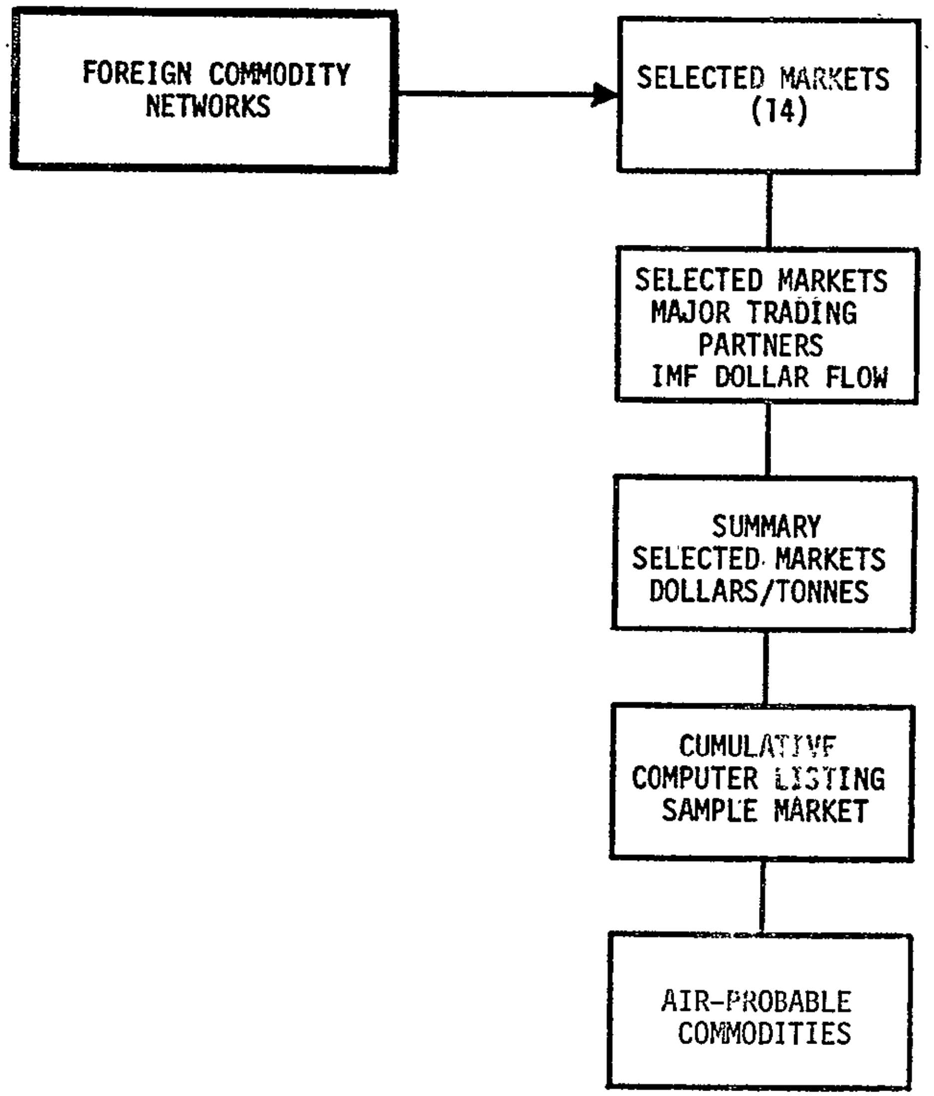

Figure 1-57. Foreign Commodity Networks Data Flow

Table 1-121 is a more detailed enumeration of the dollar flow for each of these countries with at least a half dozen of the important trading partner countries. From this set of highly dynamic trading flows, a selection was then made of the one outstanding trade channel of vessel liner traffic. Since the growth potential of airfreight is essentially determined by natural growth or expansion of international trade, it was logical to select current markets of known vitality. The trade totals for each of these flows has been listed in Table 1-122. These data were extracted from the U.S. 1975 trade data base (in contrast to the IMF dollar flow data used in the two prior tables) and include annual value and tonnage of goods transported for that market.

To provide additional definition of selected networks, computer detail of commodities is output for each of these market flows. Table 1-123 is a sample page of such commodity detail in the Italy to Germany market.

To provide further commodity definition, these same cumulative listings of commodity detail were utilized to list goods of reasonably high value being traded in good tonnage volume. Tables 1-124 through 1-137 exhibit these data for all 14 markets which tend to indicate air-potential commodities.

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TABLE 1-121
FOREIGN COMMODITY NETWORKS 1975 IMF TRADE

Country	Trading Partner Country	($ 10^9)	
		Exports	Imports
UK TO	CANADA	1.2	1.9
	GERMANY	2.9	4.4
	FRANCE	2.6	3.6
	AUSTRALIA	1.4	0.6
	JAPAN	0.7	1.5
	SOUTH AFRICA	1.5	1.4
	IRAN	1.1	1.6
	HONG KONG	0.4	0.7
	SWEDEN	1.8	2.0
	BRAZIL	0.4	0.4
ITALY TO	GERMANY	6.5	6.6
	FRANCE	4.6	5.1
	UK	1.6	1.3
	YUGOSLAVIA	0.8	0.4
	SAUDI ARABIA	0.4	2.4
	BRAZIL	0.5	0.5
	SOUTH AFRICA	0.4	0.6
	JAPAN	0.3	0.5
JAPAN TO	CANADA	1.2	2.5
	GERMANY	1.7	1.2
	UK	1.5	0.8
	AUSTRALIA	1.8	4.2
	SOUTH AFRICA	0.9	0.9
	IRAN	1.9	5.0
	INDONESIA	1.9	3.4
	TAIWAN	1.8	0.8
	BRAZIL	0.9	0.9

TABLE 1-121. - Continued

FOREIGN COMMODITY NETWORKS

Country	Trading Partner Country	($ 10^9)	
		Exports	Imports
SOUTH AFRICA TO	CANADA	0.2	0.1
	JAPAN	0.7	0.9
	UK	1.2	1.5
	GERMANY	0.6	1.4
	SWITZERLAND	0.3	0.2
	BELGIUM	0.2	0.2
HONG KONG TO	JAPAN	0.4	1.4
	GERMANY	0.6	0.2
	UK	0.6	0.4
	AUSTRALIA	0.3	0.2
	SINGAPORE	0.3	0.4
	SWITZERLAND	0.3	0.2
GERMANY TO	JAPAN	1.0	1.7
	BRAZIL	1.2	0.9
	SOUTH AFRICA	1.4	0.9
	FRANCE	10.6	0.9
	SWEDEN	3.3	1.8
	NETHERLANDS	9.0	10.5
	IRAN	2.1	1.5
	HONG KONG	0.2	0.7
	VENEZUELA	0.4	0.3
AUSTRALIA TO	JAPAN	3.5	1.8
	CANADA	0.4	0.2
	GERMANY	0.4	0.7
	UK	0.6	1.5
	NEW ZEALAND	0.6	0.3
	HONG KONG	0.2	0.2
	ITALY	0.2	0.3
	SINGAPORE	0.3	0.2

TABLE 1-121. - Continued

FOREIGN COMMODITY NETWORKS

Country	Trading Partner Country	($ 10^9)	
		Exports	Imports
IRAN TO	CANADA	0.8	0.1
	JAPAN	4.5	1.7
	FRANCE	1.2	0.5
	GERMANY	1.3	1.8
	UK	1.4	0.9
	NETHERLANDS	1.5	0.3
	BELGIUM	0.4	0.3
NIGERIA TO	JAPAN	0.3	0.6
	FRANCE	0.9	0.5
	GERMANY	0.6	0.9
	NETHERLANDS	0.9	0.3
	UK	1.2	1.4
	DUTCH ANTILLES	0.6	-
BRAZIL TO	JAPAN	0.8	1.0
	GERMANY	0.8	1.3
	ITALY	0.4	0.6
	UK	0.4	0.4
	CANADA	0.2	0.2
	NORWAY	0.3	0.2
	SPAIN	0.4	0.1
	ARGENTINA	0.3	0.3
INDONESIA TO	JAPAN	2.9	1.8
	GERMANY	0.2	0.4
	NETHERLANDS	0.2	0.2
	SINGAPORE	0.5	0.4
	ITALY	0.1	0.1
	FRANCE	0.1	0.1

TABLE 1-121. - Concluded
FOREIGN COMMODITY NETWORKS

Country	Trading Partner Country	($ 10^9)	
		Exports	Imports
BOLIVIA TO	JAPAN	0.1	0.1
	ARGENTINA	0.1	0.1
	SPAIN	-	-
	UK	-	-
	GERMANY	0.1	0.1
	BELGIUM	-	-
MOROCCO TO	FRANCE	0.4	0.6
	ITALY	0.2	0.1
	SPAIN	0.1	0.1
	BELGIUM	0.1	0.1
	GERMANY	0.2	0.2
	NETHERLANDS	0.1	0.1
VENEZUELA TO	CANADA	1.3	0.3
	UK	0.3	0.1
	GERMANY	0.3	0.3
	JAPAN	0.1	0.4
	BRAZIL	0.2	0.1
	ITALY	0.1	0.2
NETHERLANDS TO	NIGERIA	0.3	0.7
FRANCE TO	MOROCCO	0.8	0.4

TABLE 1-122

SELECTED FOREIGN COMMODITY NETWORKS, MARKET SUMMARY - 1975 U.N. DATA

Market	Tonnes	($ 10^6)
UK TO FRANCE	917 643	2 315.5
ITALY TO GERMANY	4 774 148	6 072.1
JAPAN TO IRAN	2 817 413	1 763.4
SOUTH AFRICA TO UK	703 857	558.6
HONG KONG TO UK	100 501	580.0
GERMANY TO BRAZIL	574 912	1 086.6
AUSTRALIA TO JAPAN	1 913 794	626.1
GERMANY TO IRAN	925 159	1 958.1
NETHERLANDS TO NIGERIA*	199 232	165.0
JAPAN TO BRAZIL*	1 162 485	893.3
JAPAN TO INDONESIA	2 266 083	1 584.5
BOLIVIA TO GERMANY	597	4.3
FRANCE TO MOROCCO*	455 304	612.1
GERMANY TO VENEZUELA*	118 531	326.3
TOTAL	16 929 659	18 545.9

TABLE 1-123

COMPUTER OUTPUT FOR SELECTED SAMPLE MARKET

UNITED NATIONS 1975 EXPORTS -- ITALY TO GERMANY FED -- ALL MODES

SITC	DESCRIPTION	$/KG ****	DOLLARS	CUM DOLLARS &	PCT	KILOS	CUM KILOS &	PCT
69793	PICTURE FRAMES MIRRORS BASE METAL	5.00	405 000	2 795 049 000	46.03	81 000	240 819 718	5.04
69840	ANCHORS, GRAPNELS AND PARTS THERE	5.00	45 000	2 795 094 000	46.03	9 000	240 828 718	5.04
72993	ELECTRIC TRAFFIC CONTROL EQUIPMEN	5.00	20 000	2 795 114 000	46.03	4 000	240 832 718	5.04
73250	ROAD TRACTORS FOR TRACTOR-TRAILER	5.00	15 000	2 795 129 000	46.03	3 000	240 835 718	5.04
73270	OTHER CHASSIS WITH ENGINES MOUNTE	5.00	155 000	2 795 284 000	46.04	31 000	240 866 718	5.05
89213	MAPS HYDROGRAPHIC CHARTS	5.00	830 000	2 796 114 000	46.05	166 000	241 032 718	5.05
89591	INKS NOT FOR PRINTING	4.93	69 000	2 796 183 000	46.05	14 000	241 046 718	5.05
65393	FABRICS WOVEN HORSEHAIR	4.91	2 000	2 796 185 000	46.05	407	241 047 125	5.05
65163	YARN OF CONTINUOUS SYNTHETIC FIBR	4.88	156 000	2 796 341 000	46.05	32 000	241 079 125	5.05
89993	ARTIFICIAL FLOWERS	4.84	595 000	2 796 936 000	46.06	123 000	241 202 125	5.05
89230	MUSIC PRINTED MANUSCRIPT	4.80	24 000	2 796 960 000	46.06	5 000	241 207 125	5.05
89422	DOLLS	4.80	1 628 000	2 798 588 000	46.09	339 000	241 546 125	5.06
71993	TRANSMISSION SHAFTS CRANKS PULLEY	4.73	9 928 000	2 808 516 000	46.25	2 099 000	243 645 125	5.10
89521	FOUNTAIN PENS PENHOLDERS ETC	4.73	7 353 000	2 815 869 000	46.37	1 555 000	245 200 125	5.14
65661	BLANKETS RUGS WOOL	4.69	507 000	2 816 376 000	46.38	108 000	245 308 125	5.14
71811	MACHINERY FOR MAKING OR FINISHING	4.68	2 376 000	2 818 752 000	46.42	508 000	245 816 125	5.15
73530	SHIPS AND BOATS, OTHER THAN WARSH	4.68	9 193 000	2 827 945 000	46.57	1 966 000	247 782 125	5.19
71992	TAPS COOKS VALVES SIMILAR APPLIAN	4.67	22 346 000	2 850 291 000	46.94	4 788 000	252 570 125	5.29
68710	TIN AND TIN ALLOYS, UNWROUGHT	4.61	129 000	2 850 420 000	46.94	28 000	252 598 125	5.29
73161	RAILWAY AND TRAMWAY SERVICE VEHIC	4.61	2 398 000	2 852 818 000	46.98	520 000	253 118 125	5.30
66411	GLASS MASS EXC OPTICAL GLASS WAST	4.60	23 000	2 852 841 000	46.98	5 000	253 123 125	5.30
71964	SPRAYING MACHINERY	4.59	1 243 000	2 854 084 000	47.00	271 000	253 394 125	5.31
65151	FLAX RAMIE YARN NOT RETAIL SALE	4.58	197 000	2 854 281 000	47.01	43 000	253 437 125	5.31
85101	FOOTWEAR OF RUBBER OR PLASTIC	4.58	66 774 000	2 921 055 000	48.11	14 578 000	268 015 125	5.61
89926	FEATHER DUSTERS	4.58	4 000	2 921 059 000	48.11	873	268 015 998	5.61
68226	TUBE AND PIPE FITTINGS OF COPPER	4.52	1 968 000	2 923 027 000	48.14	435 000	268 450 998	5.62
89424	INDOOR GAME EQUIPMENT	4.46	991 000	2 924 018 000	48.16	222 000	268 672 998	5.63
29261	BULBS TUBERS CORMS CROWNS RHIZOME	4.45	49 000	2 924 067 000	48.16	11 000	268 683 998	5.63
66382	FRICTION MATERIALS ASBESTOS OTHER	4.45	649 000	2 924 716 000	48.17	146 000	268 829 998	5.63
00110	CATTLE - LIVE	4.42	84 000	2 924 800 000	48.17	19 000	268 848 998	5.63
69525	CUTTING BLADES FOR MACHINES	4.42	345 000	2 925 145 000	48.17	78 000	268 926 998	5.63
89924	BROOMS BRUSHES MOPS PAINT ROLLERS	4.42	1 285 000	2 926 430 000	48.20	291 000	269 217 998	5.64
72992	ELECTRIC FURNACES ELECTRIC WELDIN	4.40	3 389 000	2 929 819 000	48.25	770 000	269 987 998	5.66
84160	APPAREL AND CLOTHING ACCESSORIES	4.38	57 000	2 929 876 000	48.25	13 000	270 000 998	5.66
71951	MACHINE TOOLS WORK MINERALS	4.35	2 549 000	2 932 425 000	48.29	586 000	270 586 998	5.67
71961	CALENDERING MACHINES SIMILAR ROLL	4.33	251 000	2 932 676 000	48.30	58 000	270 644 998	5.67
81242	LAMPS LIGHTING FITTINGS AND PARTS	4.32	14 734 000	2 947 410 000	48.54	3 412 000	274 056 998	5.74
89523	PENCILS CRAYONS ETC	4.31	220 000	2 947 630 000	48.54	51 000	274 107 998	5.74
89957	TAILORS DUMMIES	4.29	356,000	2,947 986 000	48.55	83 000	274 190 998	5.74
63281	TOOLS HANDLES SHOE LASTS ETC OF W	4.27	47,000	2,948 033 000	48.55	11 000	274 201 998	5.74

TABLE 1-124

FOREIGN COMMODITY NETWORKS

UK to France 365 Air Kilometers

Total $ 2 315 500 000

Total Tonnes 917 643

SITC	Commodities	Tonnes	$ 10^6	$/Kg
73492	Aircraft Parts	1 553	111.7	71.94
71430	Statistical Machines	1 778	88.4	49.69
89601	Paintings	808	20.4	25.26
86169	Photo Equipment	1 592	30.6	19.20
54170	Medicaments	510	7.4	14.51
72930	Thermionic Valves	1 815	24.6	13.57
86171	Medical Instruments	1 019	11.1	10.92
86429	Clock Parts	502	5.1	9.97
89120	Phonograph Records	658	6.2	9.45
71954	Tool Parts	955	7.5	7.88
12220	Cigarettes	1 324	9.9	7.48
71921	Pumps	1 499	9.8	6.53
72492	Microphones	1 032	6.7	6.45
		15 045	339.4	22.55

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TABLE 1-125

FOREIGN COMMODITY NETWORKS

Italy to Germany 957 Air Kilometers

Total $ 6 072 100 000

Total Tonnes 4 774 148

SITC	Commodities	Tonnes	$ 10^6	$/Kg
71430	Statistical Machines	1 095	49.3	45.08
84112	Womens Garments	3 686	92.4	25.06
89711	Jewelry	4 160	82.4	19.80
84144	Knitted Garments	26 661	484.6	18.18
72499	Telecommunications Equipment	2 116	33.3	15.78
83100	Travel Goods	4 845	66.4	13.71
72410	TV Receivers	7 246	81.5	11.25
85102	Leather Footwear	41 558	402.4	9.68
65321	Woven Fabrics	18 004	137.9	7.66
65352	Synthetic Fabrics	8 848	57.4	6.48
71510	Machine Tools	5 701	30.5	5.35
85101	Rubber Footwear	14 578	66.8	4.58
29271	Cut Flowers	11 923	47.0	3.94
		150 421	1 631.9	10.85

TABLE 1-126

FOREIGN COMMODITY NETWORKS

Japan to Iran 7 676 Air Kilometers

Total $ 1 763 400 000

Total Tonnes 2 817 413

SITC	Commodities	Tonnes	$ 10^6	$/Kg
72499	Telecommunications Equipment	522	12.0	22.95
72491	Telephone Equipment	787	14.6	18.52
72420	Radios	1 986	28.3	14.24
72220	Electrical Apparatus	722	8.4	11.64
71921	Pumps	508	5.0	9.74
65223	Cotton Fabrics	1 021	7.2	7.11
71980	Mechanical Appliances	866	5.6	6.44
71712	Weaving Machinery	1 641	9.5	5.81
65351	Woven Fabrics	4 652	27.0	5.80
71919	Cooling Equipment	2 356	13.4	5.70
71150	Internal Combustion Engines	3 469	19.1	5.52
72210	Electrical Power Machinery	3 457	16.7	4.84
69606	Tableware	1 429	6.1	4.24
72505	Space Heating Equipment	1 874	7.3	3.87
73291	Motorcycle Parts	6 853	24.1	3.51
71841	Excavation Equipment	17 578	43.0	2.45
		49 722	247.3	4.97

TABLE 1-127

FOREIGN COMMODITY NETWORKS

South Africa to UK 9 667 Air Kilometers

Total $ 558 600 000

Total Tonnes 703 857

SITC	Commodities	Tonnes	$ 10^6	$/Kg
21200	Fur Skins	733	55.0	74.96
89601	Paintings	317	8.0	25.26
51500	Radioactive Material	7170	91.9	12.82
69524	Hand Tools	59	0.7	10.98
71992	Valves	161	1.0	6.18
61140	Leather	170	1.0	5.84
71993	Transmission Shafts	198	1.0	5.19
51369	Inorganic Base	473	2.2	4.58
73289	Auto Parts	393	1.0	2.56
		9674	161.8	16.72

TABLE 1-128

FOREIGN COMMODITY NETWORKS

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Hong Kong to UK 10 464 Air Kilometers

Total $ 580 000 000

Total Tonnes 100 501

SITC	Commodities	Tonnes	$ 10^6	$/Kg
84112	Girls Garments	2 914	57.1	19.60
84144	Knitted Garments	4 824	76.7	15.89
72420	Radios	1 011	14.4	14.24
84111	Boys Garments	5 986	77.9	13.02
84143	Undergarments	2 336	26.4	11.30
84113	Mens Garments	5 171	55.0	10.62
65229	Cotton Fabrics	2 298	13.7	5.94
89423	Toys	6 447	27.5	4.27
69721	Domestic Utensils	3 161	9.8	3.11
65213	Cotton Fabrics	12 200	34.1	2.79
		46 348	392.6	8.47

TABLE 1-129

FOREIGN COMMODITY NETWORKS

Germany to Brazil 9 564 Air Kilometers

Total $ 1 086 600 000

Total Tonnes 574 912

SITC	Commodities	Tonnes	$ 10^6	$/Kg
72491	Electrical Line	1 097	30.5	27.76
72220	Electrical Apparatus	1 250	25.4	20.29
71954	Machine Tool Parts	1 382	21.4	15.47
71829	Printing Machines	1 132	13.6	11.96
72992	Electrical Furnaces	597	6.7	11.29
71712	Weaving Machines	1 147	10.9	9.50
71711	Spinning Machines	4 039	38.4	9.47
71980	Mechanical Appliances	3 824	34.5	9.01
71510	Machine Tools	10 787	93.8	8.69
71922	Pumps	2 439	17.2	7.05
71851	Mineral Equipment	4 330	60.0	6.31
73289	Auto Parts	5 920	28.4	4.80
		37 944	380.8	10.04

TABLE 1-130
FOREIGN COMMODITY NETWORKS

Australia to Japan 7 814 Air Kilometers
Total $ 626 100 000
Total Tonnes 1 913 794

SITC	Commodities	Tonnes	$ 10^6	$/Kg
68110	Silver	309	6.2	20.18
54170	Medicaments	143	1.9	13.17
03202	Crustacea	534	2.5	4.72
71915	Refrigerators	512	2.0	3.89
73210	Autos	660	2.0	3.01
69711	Domestic Stoves	1 188	2.5	2.07
03130	Crustacea	16 152	29.3	1.81
		19 498	46.4	2.38

TABLE 1-131

FOREIGN COMMODITY NETWORKS

Germany to Iran 3 819 Air Kilometers

Total $ 1 958 100 000

Total Tonnes 925 159

SITC	Commodities	Tonnes	$ 10^6	$/Kg
72491	Electrical Line	1 704	48.5	28.47
71954	Machine Tool Parts	432	6.7	15.50
72220	Electrical Aparatus	2 698	33.7	12.48
71829	Printing Machinery	830	8.8	10.63
54170	Medicaments	2 168	21.6	9.99
71711	Extruding Machines	5 942	50.3	8.47
71510	Machine Tools	4 061	31.5	7.74
71919	Cooling Equipment	2 824	19.2	6.78
71150	Internal Combustion Engines	9 340	60.9	6.52
71980	Mechanical Appliances	14 665	85.2	5.81
72210	Power Machinery	7 510	43.6	5.81
72999	Electrical Equipment	3 047	17.0	5.58
71923	Filtering Equipment	5 002	24.4	4.88
73289	Auto Parts	41 807	163.8	3.92
		102 030	615.2	6.03

TABLE 1-132

FOREIGN COMMODITY NETWORKS

Netherlands to Nigeria 5 082 Air Kilometers

Total $ 165 000 000

Total Tonnes 199 232

SITC	Commodities	Tonnes	$ 10^6	$/Kg
71715	Textile Machines	255	3.0	11.65
71980	Mechanical Appliances	350	2.3	6.49
71842	Leveling Equipment	935	3.6	3.89
73250	Tractors	907	3.4	3.72
65161	Yarn	780	2.9	3.69
73230	Trucks	1 998	6.2	3.11
71931	Lifting Equipment	303	0.9	2.91
09909	Food Preparers	1 971	5.4	2.71
73530	Boats	2 577	6.8	2.64
		10 076	34.5	3.42

TABLE 1-133

FOREIGN COMMODITY NETWORKS

Japan to Brazil 18 557 Air Kilometers

Total $ 893 300 000

Total Tonnes 1 162 485

SITC	Commodities	Tonnes	$ 10^6	$/Kg
71420	Calculating Machines	443	14.7	33.16
72499	Telecommunications Equipment	360	8.3	22.95
72491	Telephone Equipment	830	17.7	21.31
72220	Electrical Equipment	1 063	16.7	15.74
72420	Radios	697	10.0	14.24
89111	Tape Recorders	419	5.6	13.27
72410	TV Receivers	2 110	21.1	10.00
71730	Sewing Machines	677	6.2	9.15
71922	Pumps	792	5.0	6.25
72930	Thermionic Valves	2 815	17.4	6.19
71712	Weaving Machines	1 566	8.5	5.38
72210	Electrical Power Machines	2 886	14.0	4.84
71510	Machine Tools	7 710	25.8	3.34
		22 368	171.0	7.64

TABLE 1-134

FOREIGN COMMODITY NETWORKS

Japan to Indonesia 5 769 Air Kilometers

Total $ 1 584 500 000

Total Tonnes 2 266 083

SITC	Commodities	Tonnes	$ 10^6	$/Kg
72499	Telecommunications Equipment	403	9.3	22.95
72220	Electrical Apparatus	1 520	20.6	13.53
72420	Radios	742	10.6	14.24
72410	TV Receivers	1 272	12.8	10.00
71992	Taps, Valves	1 704	16.9	9.92
71730	Sewing Machines	644	5.7	8.77
71923	Filtering Equipment	970	7.1	7.26
71713	Weaving Machines	1 853	12.4	6.70
71711	Spinning Machines	5 439	36.3	6.67
65370	Knitted Fabrics	1 411	8.7	6.13
71150	Internal Combustion Engines	3 762	22.2	5.92
71919	Cooling Equipment	5 916	30.2	5.13
65351	Fabrics, Woven	6 035	29.4	4.89
73291	Motorcycle Parts	20 133	70.7	3.51
		51 804	292.9	5.65

TABLE 1-135
FOREIGN COMMODITY NETWORKS

Bolivia to Germany 10 490 Air Kilometers
Total $ 4 300 000
Total Tonnes 597

SITC	Commodities	Tonnes	$ 10^6	$/Kg
89604	Postage Stamps	26	0.5	15.84
68710	Tin Alloys	395	2.6	6.62
21190	Skins, etc.	21	0.2	5.43
05171	Brazil Nuts	78	0.2	1.56
07110	Coffee	35	0.1	1.31
		555	3.6	6.48

TABLE 1-136

FOREIGN COMMODITY NETWORKS

France to Morocco 1 906 Air Kilometers

Total $ 612 100 000

Total Tonnes 455 304

SITC	Commodities	Tonnes	$ 10^6	$/Kg
71430	Statistical Machines	58	2.9	48.78
72499	Telecommunications Equipment	291	8.6	29.48
72491	Telephone Lines	847	21.2	25.08
86199	Parts Measuring	97	1.7	17.36
54170	Medicaments	1 184	14.7	12.43
82109	Furniture Parts	196	2.2	11.53
72220	Apparatus, Breaking	1 227	12.3	10.01
71150	Internal Combustion Engines	627	5.6	8.88
71923	Filtering Equipment	644	4.6	7.14
89211	Book-Pamphlets	742	5.1	6.83
71922	Pumps	562	3.7	6.56
71992	Taps, Valves	1 200	7.0	5.82
71980	Mechanical Appliances	1 845	9.8	5.30
73289	Auto Parts	2 668	11.1	4.15
		12 188	110.5	9.06

TABLE 1-137

FOREIGN COMMODITY NETWORKS

Germany to Venezuela 8 069 Air Kilometers

Total $ 326 300 000

Total Tonnes 118 531

SITC	Commodities	Tonnes	$ 10^6	$/Kg
72491	Electrical Equipment	212	7.7	36.09
71962	Machines for Cleaning	293	6.4	21.76
71730	Serving Machines	160	2.9	18.15
72220	Apparatus for Breaking	430	6.7	15.46
71921	Pumps	332	4.9	14.62
71715	Textile Machinery	306	3.3	10.86
54170	Medicaments	362	3.8	10.48
71711	Extruding Machines	787	7.0	8.83
71829	Printing Machines	504	4.0	8.00
71510	Machine Tools	1 035	7.6	7.32
73210	Autos	2 667	17.6	6.58
73289	Auto Parts	1 412	9.3	6.55
71980	Mechanical Appliances	1 887	10.6	5.61
71851	Mineral Crushing Equipment	2 363	12.4	5.23
72210	Electrical Power Machines	2 271	8.7	3.84
		15 021	112.9	7.52

Foreign airfreight markets. - The task of analyzing foreign airfreight markets involves problems very much the same as those encountered with U.S. international air traffic. It is essential that developing patterns of trade be understood similar to those of international tourism. Figure 1-58 shows the basic data flow for foreign airfreight markets. The data base used to characterize the foreign markets is the United Nations trade data. While it does not provide a split out of air traffic, it represents the only substantial and reliable data set available. For the purposes of this study, a set of six foreign airfreight markets was chosen from within the foreign commodity networks defined above.

Selected foreign airfreight markets:

- UK to Germany
- Germany to UK
- UK to Saudi Arabia
- Saudi Arabia to UK
- Germany to Japan
- Japan to Germany

These markets represent heavy arterial flows of external trade in goods and dollars and are key countries in the Organization for Economic Cooperation and Development (OECD) organization. The total trade for each of the markets is exhibited in Table 1-138.

TABLE 1-138

UN 1975 TRADE DATA

SELECTED FOREIGN AIR MARKETS

	Total Tonnes	$ 10^6
DHA-LON	2 435	19.1
LON-DHA	153 840	422.2
FRA-LON	2 408 690	3 972.4
LON-FRA	920 739	2 388.1
FRA-TYO	139 400	792.6
TYO-FRA	1 588 273	1 061.6
Total	5 213 377	8 656.0

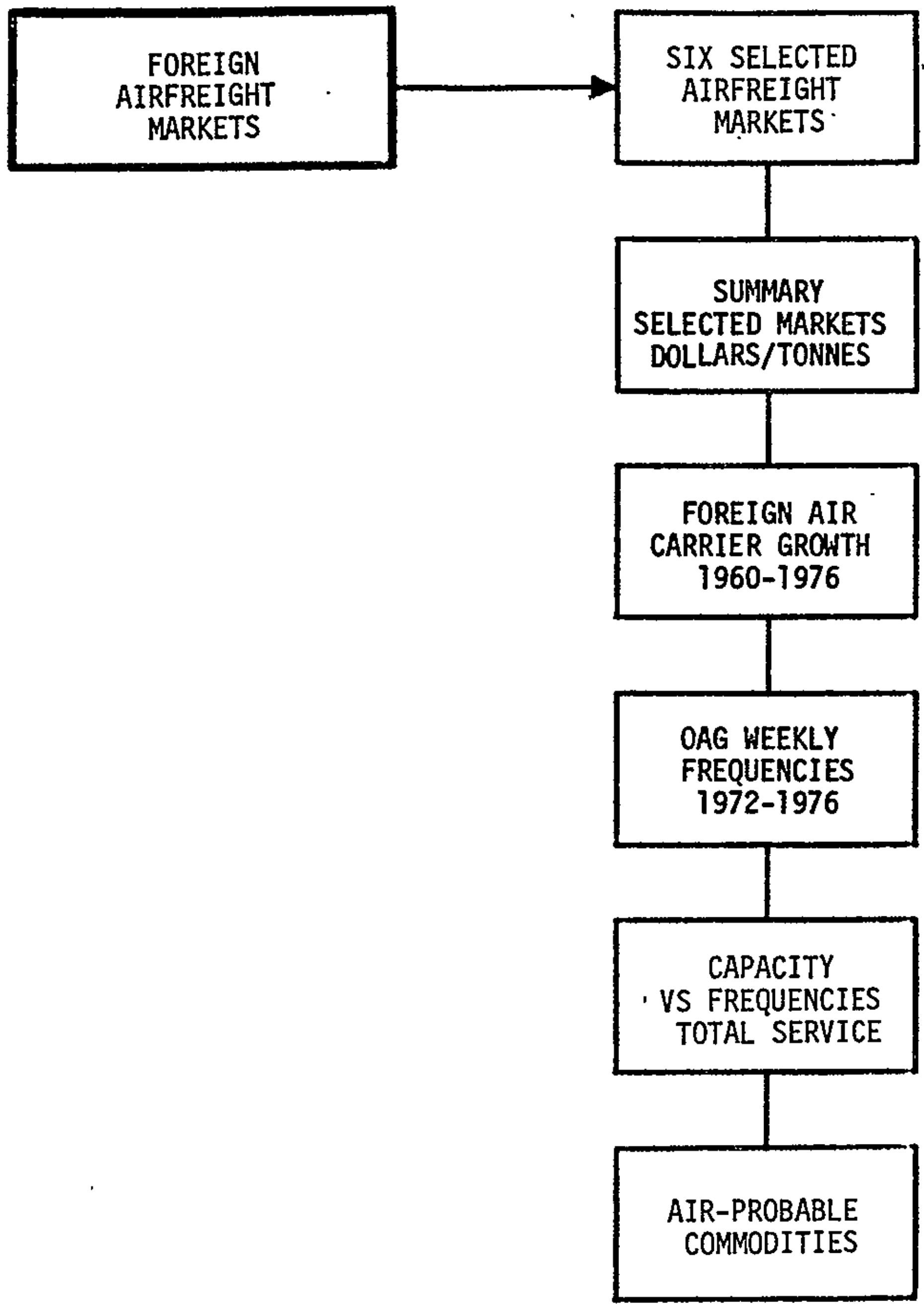

Figure 1-58. Foreign Airfreight Markets Data Flow

One of the objectives is to characterize representative trade flows and airfreight markets. Accordingly, historical airfreight growth has been developed for total transport by all classes of carriers. This growth trend is shown graphically in Figure 1-59 (References 1-28 and 1-29) from 1960 through 1976. Over the full 17-year period, the annual airfreight growth exceeded 58 percent. Over the more recent period, 1968 through 1976, this growth rate equalled 21 percent.

To further characterize the current airfreight markets, OAG data was utilized to indicate airfreight capacity offered and at existing frequencies. Table 1-139 lists weekly frequencies offered (month of August) for 1972 through 1977 for each of the six markets. Tables 1-140 through 1-142 show the weekly tonnage capacity offered by passenger aircraft and all-freighter aircraft. These data seem to indicate that by all types of aircraft, total capacity offered has indeed leveled off with exception of the Frankfurt-to-London market.

A general indication of products that are most likely air potential have been tabulated in Tables 1-143 through 1-148. They were selected from cumulative data listings for each market on the basis of either high dollars per kilogram commodity value, high tonnage, or both.

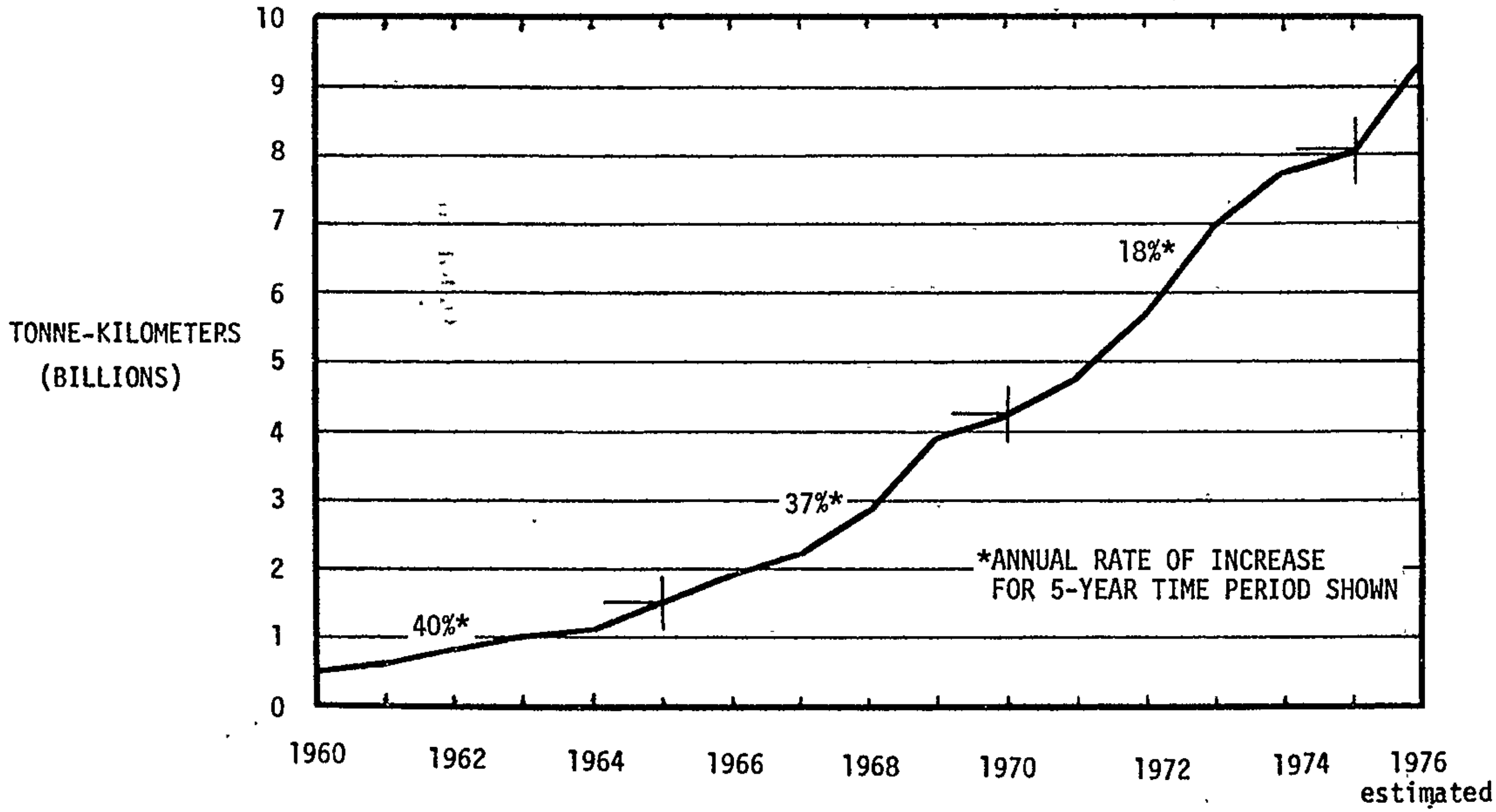

Figure 1-59. Top 48 Foreign Carriers Scheduled Airfreight Traffic Performed - 1960-1976

TABLE 1-139

FOREIGN AIRFREIGHT MARKETS
WEEKLY FREQUENCIES - PASSENGER AND ALL-FREIGHTER
SERVICES FOR SELECTED MARKETS, 1972-1977 (MONTH OF AUGUST)

Market	1972		1973		1974		1975		1976		1977	
	PAX	AF	PAX	AF	PAX	AF	PAX	AF	PAX	AF	PAX	AF
DHA-LON	5	-	4	-	11	-	11	2	8	2	9	2
LON-DHA	4	1	5	2	10	3	11	3	7	3	8	3
FRA-LON	111	36	104	40	96	37	78	27	81	27	84	29
LON-FRA	117	35	110	35	98	32	78	27	78	26	82	22
FRA-TYO	21	6	22	8	20	9	19	6	19	8	20	6
TYO-FRA	22	7	22	7	20	7	19	6	19	8	16	4

TABLE 1-140

FOREIGN AIRFREIGHT MARKETS
ESTIMATED CAPACITY OFFERED PER WEEK - PASSENGER SERVICES
1972 - 1977

City Pair	Tonnes Date and Percent Change										
	8/72	8/73	%	8/74	%	8/75	%	8/76	%	8/77	%
DHA-LON	15.5	12.1	(22)	37.9	213	41.3	9	36.4	(12)	4.61	14
LON-DHA	12.1	15.5	28	34.5	122	41.3	20	31.4	(24)	38.7	12
FRA-LON	447.7	407.6	(9)	407.2	0	447.7	11	429.1	(4)	409.4	(5)
LON-FRA	473.5	458.3	(3)	425.1	(7)	447.7	5	417.1	(7)	385.4	(7)
FRA-TYO	155.5	174.8	12	187.4	7	179.7	(4)	179.7	0	193.1	7
TYO-FRA	158.0	174.8	11	187.4	7	179.7	(4)	179.7	0	163.6	9

TABLE 1-141

FOREIGN AIRFREIGHT MARKETS
WEEKLY ESTIMATED CAPACITY OFFERED - ALL-FREIGHTER SERVICES
1972 - 1977

City Pair	Date and Percent Change										
	8/72	8/73	%	8/74	%	8/75	%	8/76	%	8/77	%
DHA-LON	-	-		-		66.5	0	66.5	0	55.4	(16)
LON-DHA	33.3	66.5	99	99.7	50	99.7	0	99.7	0	83.1	(16)
FRA-LON	831.5	1019.6	23	971.8	(5)	590.5	(39)	853.2	44	1150.7	35
LON-FRA	770.5	853.4	11	762.3	(10)	648.0	(15)	694.0	7	457.5	(34)
FRA-TYO	199.4	266.0	33	299.2	12	177.2	(59)	243.7	37	177.2	(27)
TYO-FRA	232.7	232.6	0	232.7	0	177.2	(24)	243.7	37	121.8	(50)

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TABLE 1-142

FOREIGN AIRFREIGHT MARKETS
WEEKLY EST. CAPACITY OFFERED - TOTAL AIR CARGO
1972 - 1977

City Pair	Date and Percent Change									
	8/72	8/73	%	8/74	%	8/75	%	8/76	%	8/77	%
DHA-LON	15.5	12.1	(22)	37.9	213	107.8	184	102.9	(5)	97.0	(5)
LON-DHA	45.4	82.0	81	134.2	64	141.0	5	131.1	(7)	121.8	(7)
FRA-LON	1279.2	1427.2	12	1379.0	(3)	1038.2	(24)	1282.3	24	1560.1	22
LON-FRA	1244.0	1311.7	5	1187.4	(10)	1095.7	(8)	1111.1	1	842.9	(24)
FRA-TYO	354.9	440.8	24	486.6	10	356.9	(26)	423.4	19	370.3	(12)
TYO-FRA	390.7	407.4	4	420.1	3	356.9	(15)	423.4	19	285.4	(33)

TABLE 1-143

FOREIGN AIRFREIGHT MARKETS

UK to Germany 654 Air Kilometers

Total $ 2 388 100 000

Total Tonnes 920 739

SITC	Commodities	Tonnes	$ 10^6	$/Kg
21200	Fur Skins	1 237	98.6	79.71
73492	Aircraft Parts	920	66.2	71.95
71430	Statistical Machines	1 931	95.2	49.30
84112	Women's Garments	399	10.1	25.31
86169	Photo Equipment	1 135	23.4	20.61
54170	Medicaments	1 497	24.1	16.10
65321	Fabrics	1 471	20.0	13.60
72930	Thermionic Valves	1 339	18.2	13.59
89111	Tape Recorders	1 524	20.3	13.32
71713	Knitting Machines	1 183	13.1	11.07
89120	Phonograph Recorders	1 342	14.8	11.03
69524	Tools, Hand	638	6.2	9.72
71999	Machine Parts	800	7.3	9.12
12220	Cigarettes	1 095	7.7	7.03
71921	Pumps	1 609	10.9	6.77
72410	TV Receivers	1 578	10.1	6.40
71992	Tops, Cooks, Valves	2,723	16.5	6.06
71980	Mechanical Appliances	5 165	29.9	5.79
72503	Electric Mechanical Appliances	2 734	15.5	5.67
71510	Machine Tools	3 379	18.1	5.36
71923	Filtering Equipment	1 777	9.2	5.18
89423	Toys	5 301	24.5	4.62
55300	Perfume, Cosmetics	2 411	10.7	4.44
89211	Books, Printed Matter	1 908	6.8	3.56
		45 096	577.4	12.80

TABLE 1-144

FOREIGN AIRFREIGHT MARKETS

Germany to UK — 654 Air Kilometers

Total $ 3 972 400 000

Total Tonnes 2 408 690

SITC	Commodities	Tonnes	$ 10^6	$/Kg
71492	Office Machine Parts	1 635	126.7	77.49
72952	Electrical Measuring Devices	1 045	55.9	53.49
71430	Statistical Machines	1 024	54.7	53.41
54170	Medicaments	1 278	31.5	24.65
86169	Photo Equipment	1 652	30.5	18.46
71410	Typewriters	1 942	29.2	15.04
71962	Machines for Cleaning	1 797	25.1	13.96
72930	Thermionic Valves	2 358	32.0	13.57
72220	Apparatus for Breaking	4 246	55.1	12.98
71713	Weaving Machines	2 059	26.7	12.97
89120	Phonograph Records	1 597	20.2	12.65
71954	Machine Tool Parts	2 161	22.9	10.60
71829	Printing Machines	2 391	23.3	9.74
71510	Machine Tools	9 989	85.4	8.55
71980	Mechanical Appliances	7 224	60.4	8.36
71970	Ball Bearings	4 493	32.4	7.21
72210	Electric Power Machines	5 614	39.4	7.02
71522	Rolling Mills	5 479	34.5	6.30
71993	Transmission Shafts	7 335	36.5	4.98
71931	Lifting and Loading Machinery	12 491	48.2	3.86
73289	Auto Parts	78 512	159.5	2.03
		156 322	1030.1	6.58

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TABLE 1-145

FOREIGN AIRFREIGHT MARKETS

UK to Saudi Arabia   5058 Air Kilometers
Total $ 422 200 000
Total Tonnes   153 840

SITC	Commodities	Tonnes	$ 10^6	$/Kg
72499	Telecom Equipment	264	15.8	59.84
86171	Medical Instruments	249	5.3	21.28
65321	Woven Fabrics-Wool	268	4.5	16.79
82102	Medical Furniture	378	4.3	11.38
89211	Books and Pamphlets	219	2.1	9.59
12220	Cigarettes	4 686	33.5	7.15
71510	Machine Tools	293	1.9	6.48
71980	Mechanical Applicances	2 632	13.9	5.28
54170	Medicaments	1 699	8.5	5.00
72220	Apparatus Electrical	1 303	6.5	4.99
71922	Pumps	1 040	4.9	4.71
72210	Electrical Power Machinery	3 138	14.6	4.65
71150	Internal Combustion Engines	2 460	10.5	4.27
62910	Tires and Tubes	816	3.1	3.80
71842	Excavation Equipment	5 572	18.5	3.32
71931	Loading Equipment	1 571	5.2	3.31
65760	Carpets	1 455	3.9	2.68
55300	Perfume	1 417	3.5	2.47
		29 460	160.5	5.45

TABLE 1-146

FOREIGN AIRFREIGHT MARKETS

Saudi Arabia to UK — 5058 Air Kilometers

Total — $ 19 100 000

Total Tonnes — 2435

SITC	Commodities	Tonnes	$ 10^6	$/Kg
71142	Jet Engines	50	6.3	126.00
73492	Aircraft Parts	54	3.9	72.22
72499	Telecom Equipment	54	1.2	22.22
72210	Electrical Machinery	72	0.7	9.72
71921	Pumps	47	0.4	8.51
		277	12.5	45.12

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TABLE 1-147

FOREIGN AIRFREIGHT MARKETS

Germany to Japan (via Moscow) 9445 Air Kilometers

Total $ 792 600 000

Total Tonnes 139 400

SITC	Commodities	Tonnes	$ 10^6	$/Kg
71492	Parts, Office Machinery	153	28.7	187.58
83100	Handbags	59	2.9	49.15
71962	Machines for Cleaning	313	12.3	39.29
54170	Medicaments	1 936	61.3	31.66
89120	Phonograph Records	270	7.1	26.29
71953	Hand Tools	236	5.0	21.18
71713	Knitting Machines	767	11.5	14.99
89211	Books	522	6.5	12.45
71980	Mechanical Appliances	1 493	17.1	11.45
71829	Printing Machines	2 123	19.7	9.28
71812	Paper Cutting Machines	1 075	8.8	8.19
51285	Compounds-Nucleic	1 921	15.5	8.07
73289	Auto Parts	1 121	8.8	7.85
71510	Machine Tools	4 779	34.5	7.84
71919	Cooling Equipment	847	5.9	6.97
71150	Internal Combustion Engines	1 086	7.4	6.81
05484	Hops	1 583	7.8	4.93
73210	Autos	17 599	82.5	4.69
71931	Lifting Machinery	1 423	5.3	3.72
07232	Cocoa Butter	2 090	7.5	3.59
		41 396	359.1	8.67

TABLE 1-148

FOREIGN AIRFREIGHT MARKETS

Japan to Germany 9445 Air Kilometers

Total $ 1 061 600 000

Total Tonnes 1 588 273

SITC	Commodities	Tonnes	$ 10^6	$/Kg
66710	Pearls	124	18.6	150.00
86112	Optical Elements	267	23.6	88.39
86140	Cameras	1 806	68.2	37.76
71420	Calculating Machines	2 086	69.2	33.17
89112	Parts, Tape Recorder	273	7.5	27.47
86150	Projectors, Cinema	1 100	27.8	25.27
72499	Telecom Equipment	643	14.8	23.01
89934	Mechanical Lighters	817	18.1	22.15
72220	Apparatus - Electrical	697	14.2	20.37
86171	Medical Instruments	910	17.1	18.79
72491	Telephone Electrical	686	10.3	15.01
72420	Radios	9 422	134.2	14.24
89111	Gramophones, etc.	6 700	88.9	13.27
86169	Photo Equipment	2 027	23.4	11.54
72410	TV Receivers	3 836	38.4	10.01
71730	Sewing Machines	3 391	26.8	7.90
89953	Slide fasteners	1 170	8.4	7.18
72930	Thermionic Valves	5 223	33.8	6.47
72492	Microphones	3 950	25.2	6.38
89423	Toys	1 993	11.4	5.72
		47 121	679.9	14.42

Distribution of airfreight worldwide. - The percentage distribution of world airfreight is depicted in the following tables and figures. Figure 1-60 shows the percentage distribution of scheduled and nonscheduled world airfreight by originating region for the year 1976. Europe and the United States vie for first position with 38 and 36 percent, respectively, of the total. Asia-Pacific is in third place with 13 percent. The remaining 13 percent is distributed between Latin America/Caribbean, Middle East, and Canada.

Nonscheduled compared to scheduled airfreight for each originating region indicates that a comparatively small amount of total airfreight moves on nonscheduled aircraft. This fact is brought out in Table 1-149 (References 1-30, 1-31, and 1-32). Nonscheduled airfreight accounts for only 10.2 percent of the total for the seven originating regions. Europe, the United States, and Africa originate between 11.4 and 13.6 percent of total airfreight per region by nonscheduled flights. Of the remaining regions, the percent of total ranges between 1.0 and 4.7.

Scheduled airfreight growth trends for the time frame 1972-1976 by originating region are shown in Table 1-150 (Reference 1-33). Because of the different data source available for this table, the United States is included in the North America region rather than separated as in the preceding table. In addition, because of a difference in reporting airlines, the totals by region for 1976 differ from the preceding table. The greatest period of growth in these 5 years for all regions was 1972-1974 with two of the regions, Middle East and Asia-Pacific, increasing over 30 percent between 1972 and 1973.

The average 5-year growth trend for the period also indicates that Africa, Middle-East, and Asia-Pacific are the regions of greatest growth with Latin America/Caribbean also showing a healthy, if less dramatic, increase. Europe and North America appear to have reached a plateau or, at least, relative stabilization. In fact, these two regions actually had decreases between 1974 and 1975.

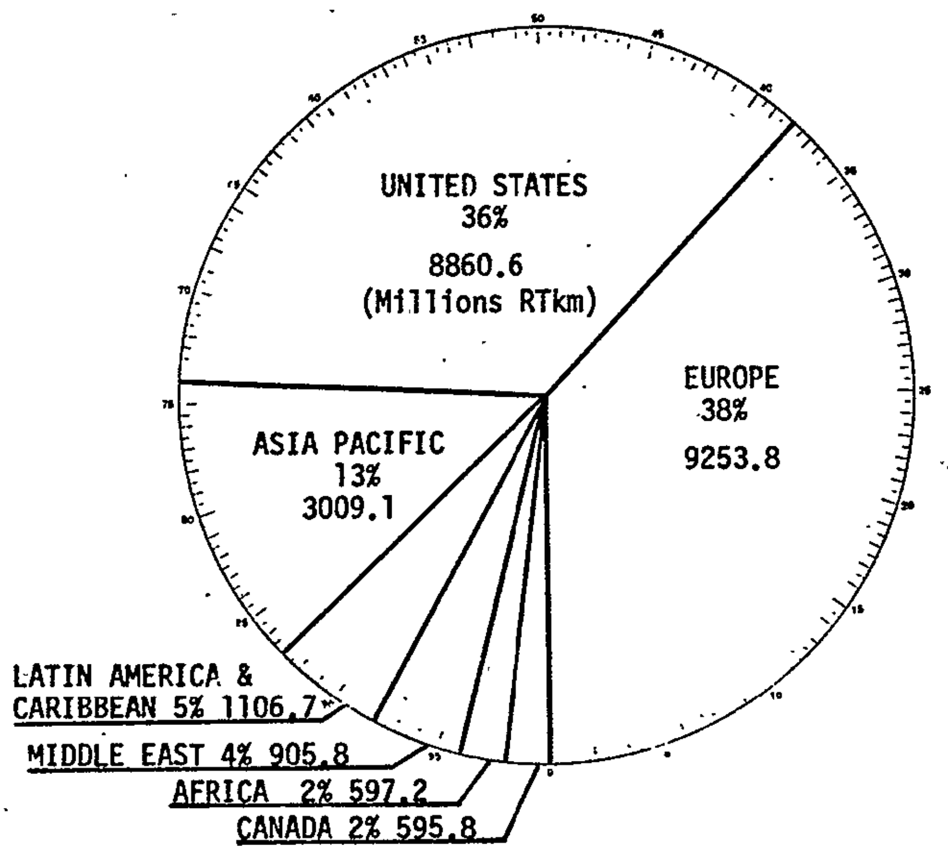

Figure 1-60. Percentage Distribution of World Airfreight by Originating Region, 1976
(Total Airfreight 24329.0 RTkm)

TABLE 1-149

PERCENTAGE DISTRIBUTION OF WORLD AIRFREIGHT BY ORIGINATING REGION, 1976

(MILLIONS OF RTKM)

Region	Scheduled		Nonscheduled[1/]		Total		Percent Of World Total
	RTkm	Percent	RTkm	Percent	RTkm	Percent	
Europe	7 992.6	86.4	1 261.2	13.6	9 253.8	100	38
United States	7 850.0	88.6	1 010.6	11.4	8 860.6	100	36
Asia Pacific	2 944.6	97.9	64.5	2.1	3 009.1	100	13
Latin America and Caribbean	1 083.3	97.9	23.4	2.1	1 106.7	100	5
Middle East	896.9	99.0	8.9	1.0	905.8	100	4
Africa	519.1	86.9	78.1	13.1	597.2	100	2
Canada	567.7	95.3	28.1	4.7	595.8	100	2
TOTALS......	21 854.2	89.8	2 474.8	10.2	24 329.0	100	100

1/ Based on reporting airlines only

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TABLE 1-150

SCHEDULED AIRFREIGHT GROWTH TRENDS BY ORIGINATING REGION, 1972-1976

(MILLIONS OF RTKM)

	Europe		Africa		Middle East		Asia-Pacific		North America		Latin America Caribbean	
Year	RTkm	Percent Change	RTkm	Percent Change	RTkm	Percent Change	RTkm	Percent Change	RTkm	Percent Change	RTkm	Percent Change
1972	5620.7		295.7		429.0		1267.1		6717.1		692.3	
1973	6533.4	16.2	365.6	23.6	591.5	37.9	1700.6	34.2	7545.9	12.3	793.3	14.6
1974	7149.1	9.4	450.6	23.2	662.4	12.0	2013.3	18.4	7777.6	3.1	963.8	21.5
1975	7121.8	- .4	476.2	5.7	763.3	15.2	2489.9	23.7	7535.6	-3.1	983.7	2.1
1976	7992.6	12.2	519.1	9.0	896.9	14.0	2944.6	18.3	8007.8	6.3	1083.3	10.1
5-Year Average Growth.......		9.4		15.4		19.8		23.7		4.7		12.1

Comparison of total scheduled and nonscheduled airfreight by country is shown in Figure 1-61 and Table 1-151 (References 1-34, 1-35, and 1-36). The top 10 countries ranked according to millions of revenue tonne-kilometers are as follows:

Country	Total Airfreight	Percent of Total
United States	8 860.6	48.4
U.S.S.R.	2 216.6	12.1
United Kingdom	1 434.0	7.8
France	1 292.4	7.1
Germany	1 138.0	6.2
Japan	1 130.8	6.2
Netherlands	695.3	3.8
Canada	595.9	3.2
Lebanon	521.0	2.8
Italy	445.1	2.4
Totals	18 329.7	100.0

Of the top 10 countries considered, it is obvious that the United States is the leader with an exact superiority of four to one over the second largest user - the U.S.S.R..

In Table 1-152 and Figure 1-62 (Reference 1-37), the major United States-based airlines are compared as to total revenue tonne-kilometers (RTkm) performed in 1976 and the amount and percent of scheduled versus nonscheduled airfreight carried.

Pan American is the leader with Flying Tigers being a close second. Pan American's performance was 1.378 million RTkm,and Flying Tigers had 1.305 million. United Airlines, American Airlines, and Trans World Airlines were third, fourth, and fifth, respectively, with RTkm ranging from 0.829 to 0.679 million RTkm. Nonscheduled airfreight for these carriers was not a significant percentage of the total RTkm. The average was 6.5 of the total with Flying Tigers having the highest percentage (11.6) and United Airlines the lowest (0.1).

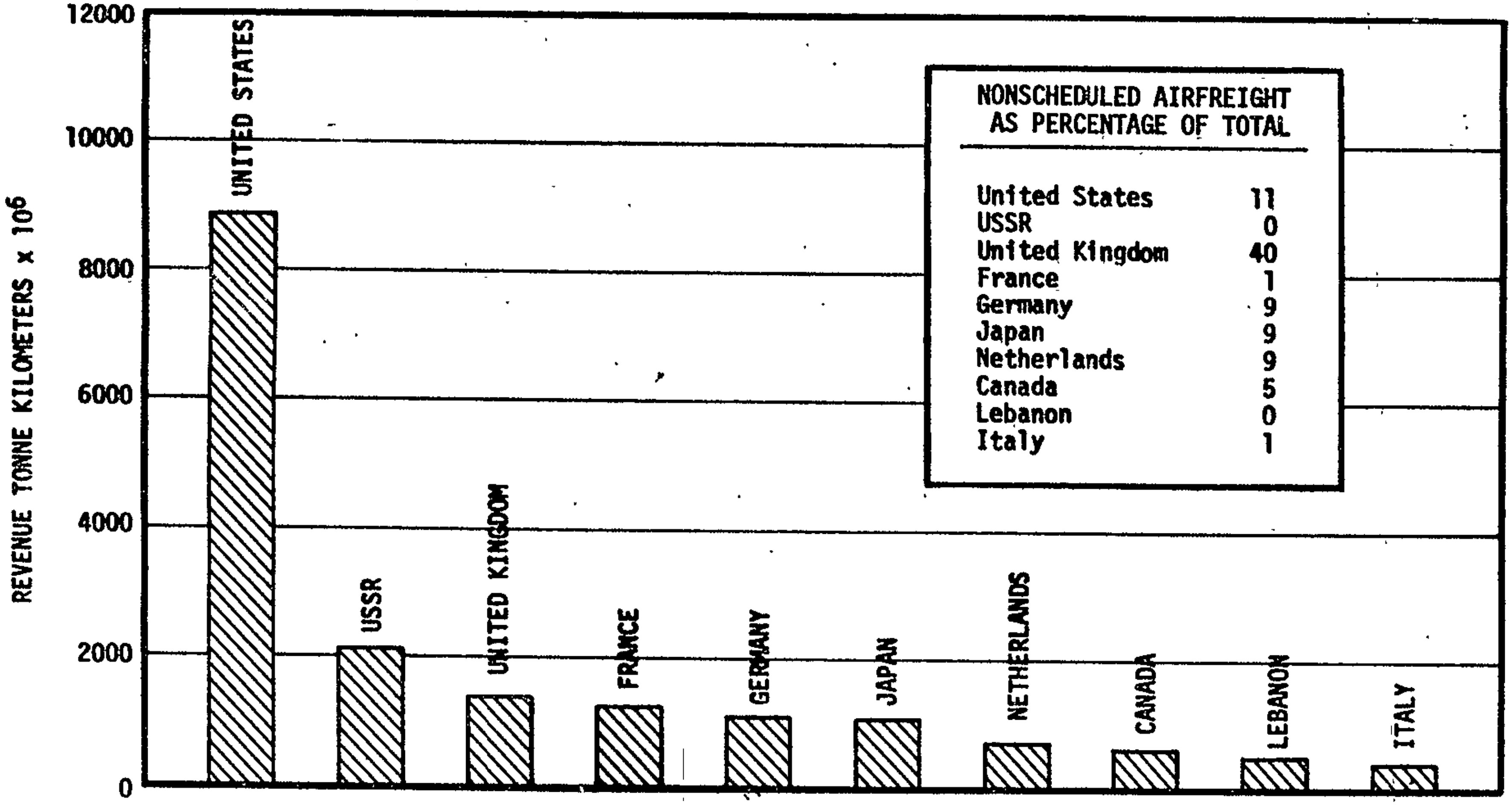

Figure 1-61. Total Scheduled and Nonscheduled Airfreight for Top 10 Countries, 1976

TABLE 1-151

PERCENTAGE DISTRIBUTION OF SCHEDULED AND NONSCHEDULED AIRFREIGHT FOR TOP 10 COUNTRIES, 1976

(MILLIONS OF RTKM)

Country	Scheduled		Nonscheduled		Total	Percent
	Amount	Percent Of Total	Amount	Percent Of Total		
United States	7850.0	89.0	1010.6	11.0	8860.6	100.0
U.S.S.R.	2216.6	100.0	--	0.0	2216.6	100.0
United Kingdom	866.4	60.0	567.6	40.0	1434.0	100.0
France	1278.9	99.0	13.5	1.0	1292.4	100.0
Germany	1040.5	91.0	97.5	9.0	1138.0	100.0
Japan	1030.8	91.0	100.0	9.0	1130.8	100.0
Netherlands	631.9	91.0	63.4	9.0	695.3	100.0
Canada	567.7	95.0	28.2	5.0	595.9	100.0
Lebanon	521.0	100.0	--	0.0	521.0	100.0
Italy	443.9	99.0	1.2	1.0	445.1	100.0

TABLE 1-152

MAJOR UNITED STATES-BASED AIRLINES

SCHEDULED COMPARED TO NON-SCHEDULED AIRFREIGHT, 1976

(REVENUE TONNE KILOMETERS x 10^6)

Airline	Scheduled		Nonscheduled		Total	
	Amount	Percent of Total	Amount	Percent of Total	Amount	Percent of Total
Pan American	1 277	92.7	101	7.3	1 378	100.0
Flying Tigers	1 155	88.4	151	11.6	1 306	100.0
United	828	99.9	1	.1	829	100.0
American Airlines	753	98.7	10	1.3	763	100.0
Trans World Airlines	657	96.8	22	1.2	679	100.0
TOTALS..................	4 670	93.5	285	6.5	4 995	100.0

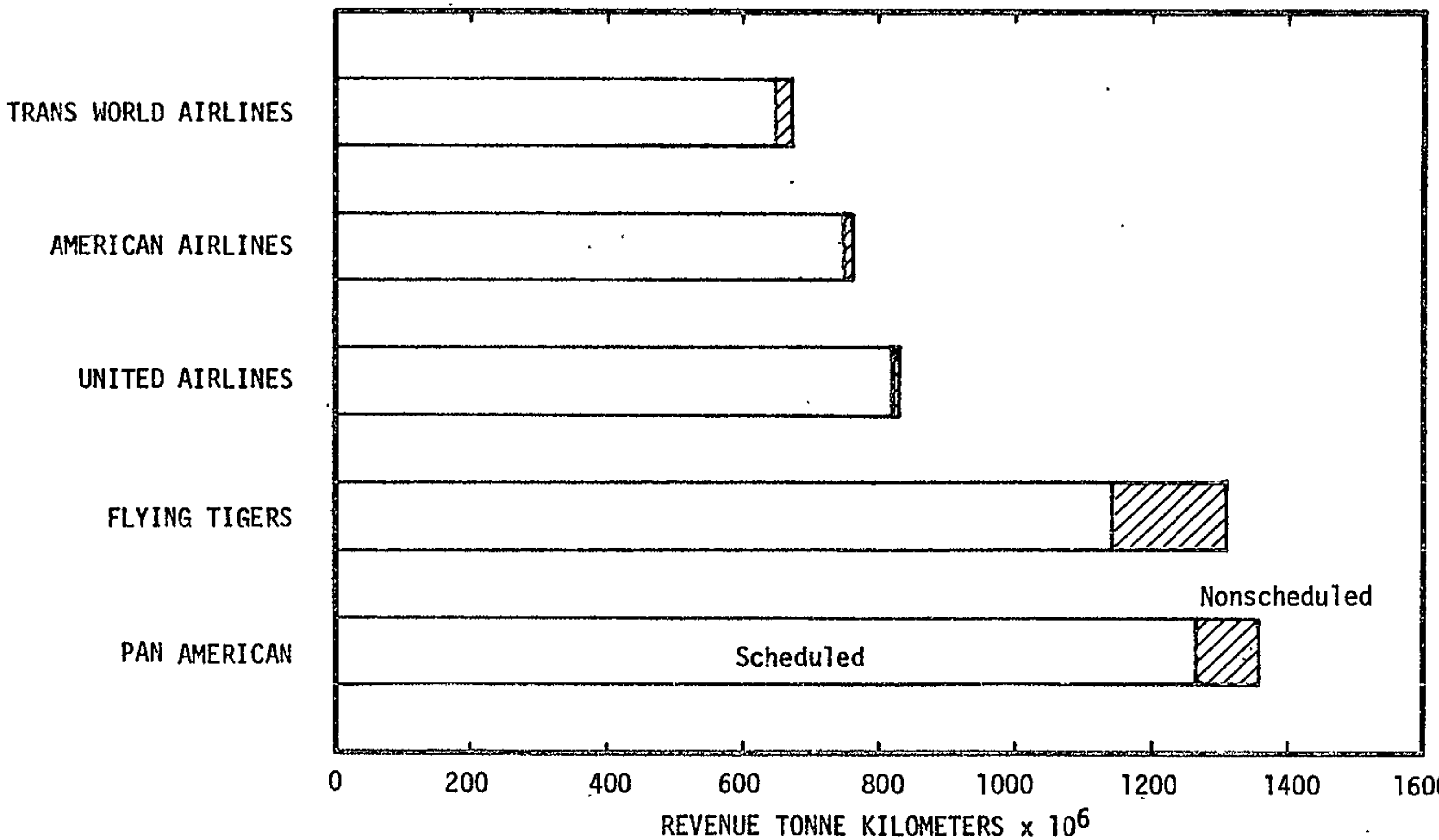

Figure 1-62. Major United States Airlines Scheduled Compared to Nonscheduled Airfreight, 1976

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Among the five largest airfreight carriers that are foreign based, Lufthansa, Japan Air Lines and Air France are the leaders in that order. British Airways and KLM are in fourth and fifth position with approximately the same performance during 1976. The comparison of scheduled and nonscheduled airfreight revenue tonne-kilometers performed by foreign-based airlines is shown in Table 1-153 and Figure 1-63 (References 1-38 and 1-39).

TABLE 1-153

MAJOR FOREIGN-BASED AIRLINES

SCHEDULED COMPARED TO NONSCHEDULED AIRFREIGHT, 1976

(REVENUE TONNE KILOMETERS X 10^6)

Airline	Scheduled		Nonscheduled		Total	
	Amount	Percent of Total	Amount	Percent of Total	Amount	Percent of Total
Lufthansa	1 041	94.8	57	5.2	1 098	100.0
JAL	981	95.1	50	4.9	1 031	100.0
Air France	937	98.5	14	1.5	951	100.0
British Airways	714	99.9	1	.1	715	100.0
KLM	630	91.8	56	8.2	686	100.0
TOTALS............	4 303	96.0	178	4.0	4 481	100.0

Note: (1) Nonscheduled is all-freight traffic

(2) Nonscheduled projected to 1976 from 1975 by multiplying by 110%

(3) Both scheduled and nonscheduled include freight and express

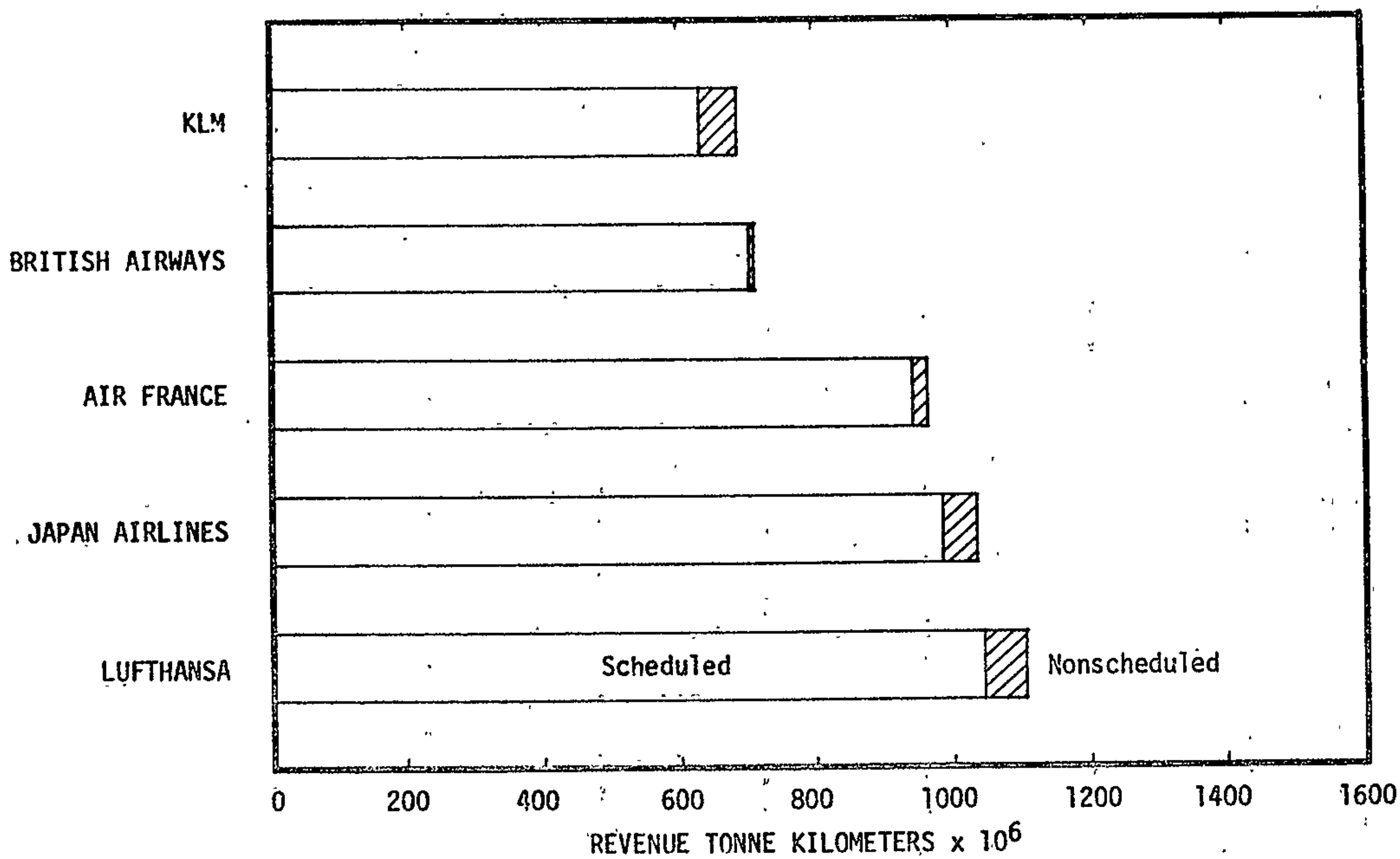

Figure 1-63. Major Foreign-Based Airlines Scheduled Compared to Nonscheduled Airfreight, 1976

SECTION 2

AIR ELIGIBILITY CRITERIA

The decision to use or not to use a particular mode to ship a particular product at a particular point in time is a function of the product and market characteristics and the decision process employed by a particular shipper or consignee. In the past, these various factors have interacted to facilitate segregation of air cargo into three basic categories, namely, emergency, perishable, and divertible. Emergency freight consists of products that are shipped by air due to the opportunity cost, such as lost sales due to delayed delivery, associated with a particular market/distribution situation and/or physical considerations. Perishable freight is made up of products that are realistically shipped by the fastest available mode due to physical and/or demand perishability. Divertible freight is that which is shipped by a variety of modes depending upon its economic and physical properties and the demand for the product. These categories of freight will be utilized in the discussions that follow.

This section will be concerned with the identification of air eligibility criteria as related to product and market characteristics. The order of discussion is that shown in Table 2-1, beginning with product-related criteria first then moving on to market criteria and finally to mode choice. The latter discussion is rather brief, intended only to outline the basic relation between the identified criteria and the decision process.

The importance of the respective product and market characteristics differ with the type of freight; not all the criteria are considered in all cases. The applicability of the respective characteristics within each of the through-freight categories is illustrated in Table 2-1. As the importance of the shipment decreases, emergency to divertible, the number of criteria pertinent to decision process, increases. Discussions of first the product then the market characteristic will proceed from emergency through perishable to divertible.

Product Characteristics

Product characteristics are a very important consideration in the mode decision process even though they cannot in themselves be viewed as mode

TABLE 2-1

AIR ELIGIBILITY CRITERIA

	Type of Freight		
	Emergency	Perishable	Divertible
Product Characteristics:	Physical Perishability → Transit Environment → Weight, Size, Volume → Lead Time →	→ → → → Value/Weight Ratio → Density →	→ → → → → → Product Range Production Process
Market Characteristics:	Opportunity Cost Value → Life-Cycle Stage → Market Location → Demand Perishability →	→ → → → Demand Variability → Mark-ups →	→ → → → → → Dispersed Demand
Mode Choice:	Fastest Available	Fastest - If Market Conditions Allow Margin Sufficient to Cover Cost	Mode Giving Lowest Total Cost of Distribution

determining. In essence, they can serve well as indicators of air cargo's potential to fulfill a company's distribution needs. As evidenced in the discussions that follow, the importance of each criterion is determined by the shipper's or consignee's unique situation and method of evaluation. While the following characteristics are not all inclusive, those identified are considered fundamental in the decision process.

Physical perishability. - Many products, such as produce, have physical characteristics that deteriorate to unacceptable levels in relatively short time, often over a time span that is less than the surface transport lead time. If fast transportation is required to avoid product perishability and market conditions allow a sufficient margin to cover the cost of the fastest mode, then, logically, air is the mode that should be employed. There are cases in existence, however, where realistic evaluations indicate that it is more economic to ship by a slower mode and accept partial perishability. In such cases, the transportation mode decision must be based upon the divertible freight criterion where the cost of physical deterioration is considered to be a component of inventory carrying costs.

Transit environment. - This criterion considers physical environment provided during transit that can affect the security of the freight from the standpoints of damage and theft. It, therefore, includes such items as handling and the atmospheric control provided for physically perishable products. Since this criterion varies with mode, the transport decision process should consider the transit environment in relation to the product and the packing required. The economics involved include not only the packing material but also the associated manpower and time required and the weight penalty entailed. However, the weight penalty may not be avoided if the shipment must travel a portion of its journey by surface mode. As pointed out in Reference 2-1, the physical environment provided by air cargo is superior to any other mode. In addition, the transit time is less, thereby reducing exposure to the risks of damage and theft.

Weight, size, and volume. - The weight, size, and volume of goods that can be transported is highly dependent upon the mode of transportation employed. Airfreight is especially restrictive with respect to weight, size, and volume, even though larger freighters are helping to relieve this situation.

Lead time. - This increment is equivalent to the time transferring between receipt of the order by the shipper and receipt of the shipment by the consignee. The real lead time must include not only transit time but also the frequency and reliability of the transport service and the time it takes to process the order. Allowable values for this criterion must be established by either the shipper and/or consignee on the basis of the considered market. In addition, this is a pertinent consideration when attempting to improve air cargo service.

Value-to-weight ratio. - If airfreight transportation costs for a commodity exceed surface transportation costs by less than the inventory carrying cost reduction made possible through the use of airfreight, then total distribution costs are minimized through the utilization of airfreight. Since inventory carrying costs relative to transportation costs increase as the commodity value-to-weight ratio increases, airfreight is more likely to minimize total distribution costs for commodities having high value-to-weight ratios. There is often a tendency, therefore, to make the mode selection on the basis of the general conclusion that the higher the value-to-weight ratio, the more likely it is that the air mode will be selected. While this criterion can serve as a general indicator, it is not a sufficient criterion for discarding air. In today's markets the intangible benefits of air cargo are becoming increasingly worthwhile, making air distribution profitable at decreasing levels of the value-to-weight ratio.

Density. - Transportation tariffs are usually a function of weight and provide shippers with the opportunity to take advantage of weight-break discounts when shipping high-density commodities. The surface modes discriminate more against lighter products than do the airlines. As a result, there is a tendency to ship the lower density by air. At the present time, the density break for air occurs at 142.7 kilograms per cubic meter. Products having greater density are charged by weight with discounts occurring at specific weight breaks. Products having lower densities are charged the 142.7-kilograms-per-cubic-meter rate for the volume they occupy.

Product range. - A diversified product line often encompasses a large variation in the rates at which the respective items are ordered. Such fluctuations in demand and slow and fast movers as well as the levels of service expected increase the costs and risks of stacking a large range of products. These difficulties can often be reduced through the selective use of air cargo for the distribution of a limited number of items out of the full range of products handled.

Production process. - Air cargo is often suggested as the means of reducing inventories; however, its applicability is a function of the production methods supplying the distribution system. For example, if a batch process is used to produce a year's supply of a product in 1 week, then transportation speed will not reduce inventory. A similar situation can exist for custom products where lead times are relatively great. However, cases do occur where rapid delivery is required to meet contract dates. In this case, it would be categorized as emergency with lead time being one of the considered criteria. Products that are produced continuously but at rates intended to meet the demand are more likely candidates for diversion to air transport.

Market Characteristics

The preceding commodity characteristics must be considered in the light of the market environment in order to realistically evaluate the economies of airfreight versus surface transport. There are many characteristics of the market place that are considered in any decision by a producer. Often times there are intangible advantages or disadvantages that can determine the course to be taken. The discussion that follows will be limited to the more prominent market characteristics that are the more determinant in deciding whether or not air cargo will provide marketing and/or distribution advantages sufficient to offset the cost.

Opportunity cost value. - Some products are shipped by the fastest available mode because of the opportunity cost associated with their movement. The opportunity cost is equivalent to the profit that could be derived from a specific market if the right products were available at the right time and in the desired quantity. In such cases, delivery costs are unimportant when compared to the loss associated with delayed delivery or delivery after the market has changed character or even disappeared. Examples of situations that could lead to such circumstances are production system shutdowns as in the auto industry, inventory stock-outs, and seasonal (time-sensitive) markets as in the cases of produce distribution and the Christmas rush and contractual deadlines. Other market characteristics, such as perishability, life-cycle stage, and market location, can also affect the opportunity cost value.

Life cycle stage. - Considerable risk is involved in putting new products on the market or in putting an existing product into a new market. Each of these situations is encompassed within the life cycle of most products. In either case, airfreight can be used to assure a responsive distribution system able to adjust to and fully exploit the potential market. In the case of new products, air mode can expedite the distribution of brochures and catalogues, the filling of the distribution channels, and the replenishment of inventories. In the case of new markets, aircraft can reduce inventory cost and extend product life through its introduction into markets where demand is uncertain and the associated risk of large inventories is high.

Market location. - Significant physical barriers to surface transportation may exist for immature and emergency markets and for markets in the developing regions of the world. Nearly all such markets have access to airports and are likely candidates for air transport. Developed markets also experience difficulties as a result of location. A well-known example of such a situation is the trade between Europe and Japan where sea traffic has the Panama Canal, Suez Canal, and the southern tip of Africa as alternative routes. In such cases, the associated distances and time delays are conducive to the consideration of the air mode as a viable alternative.

Demand perishability. - The sale of some products is often time sensitive from the standpoint of demand. This time sensitivity is a primary concern in the case of products subject to obsolescence due to fad, fashion, or technological change and products subject to seasonal variations originating with the product itself, social customs, and commercial practices. There is also perishability due to substitution which is of special concern when the market is competitive enough for local conditions to set the acceptable lead time and/or when close substitutes are locally produced. To avoid such demand perishability, transportation via the fastest mode is desired providing market conditions allow a sufficient margin to cover the cost of that mode. As for physical perishability, there can be situations where it is economically realistic to ship by a slower mode and accept the resulting partial perishability. In such situations, the cost of lost sales is considered to be a component of inventory carrying costs and as such should enter into the mode decision process.

Demand variability. - Air cargo has the potential to reduce stock in inventory, in on-order processing, and in transit. For markets where the demand is volatile, the air mode can, therefore, be used to meet either greater or less than the expected demand with a resulting reduction of the risk associated with large inventories.

Markups. - There are goods for which the markup, (Reference 2-1) difference between selling price and cost exclusive of transportation costs, depends on the market situation. In such markets, a trade-off often exists between risk and profit. Slow forms of transportation can be used to maximize profit at the risk of a change in market situation reducing potential sales, or fast forms of transportation (i.e., airfreight) can be used to take expeditious advantage of the market situation providing the markup is sufficient to cover the distribution costs associated with airfreight. In such market situations, the desirability of using airfreight depends on the size of the markup (per pound of freight) not the product value per pound of freight.

Dispersed demand. - In markets where production and consumption are geographically concentrated, the eligibility of airfreight is limited. On the other hand, when production and consumption are dispersed and/or when the production process is widely dispersed, the application of air delivery may be justified. In such cases, the use of air cargo to reduce and maintain inventories or to reduce lead time could provide savings that exceed the increased delivery costs while maintaining any loss in sales to an acceptable level. In order to realize these favorable results there must be an adequate supply of the product and an efficient order-processing system at the point of origin. From the standpoint of transportation, the frequency of the air cargo service must be adequate to handle the flow and at the time required.

Mode Choice

Air cargo is not always the most expensive mode of transport. There are cases when the air tariffs are literally lower than those for the surface modes. In such cases, the lower cost combined with service and environmental advantages make the choice clear cut. In those cases where the rates are higher, the mode choice should consider the total distribution cost in the framework of the shipper's production system. In the case of a manufacturer, the production system will include material acquisition, fabrication or processing, and distribution of the finished product.

The product and market characteristics outlined in the preceding pages enter into the decision process when the choice of mode must be made on the system basis. These criteria initially serve to qualitatively indicate a product's applicability to air transport. Once the cost benefit analysis is underway they serve to identify factors and considerations to be included in the analysis. In the majority of cases, these criteria are quantifiable to the level required for decision. There are cases when the product and/or market prevent their quantification with the result that they are often ignored. This procedure may lead to erroneous conclusions since it appears that qualitative analysis can identify potential benefits that are becoming increasingly important in today's competitive markets.

Section 3

CURRENT DIRECT SUPPORT INFRASTRUCTURE

Direct support infrastructure for current air cargo operations was surveyed during July and August 1977 by a team of Douglas Aircraft Company engineers from Airport Aircraft Compatibility and Cargo Systems Engineering groups. Survey observations and published information were used to assess the impact of the airport landside and airside elements on the total air cargo system. For a sampling of domestic airports, capacity and constraints for cargo operations were studied as an increment of total airport operations. Cargo-processing systems were observed at each airport and were documented to provide a qualitative and quantitative basis for relating terminal and airport capabilities. Terminal processing systems and functional elements were evaluated to establish productivity trends for various mechanization and cargo flow levels as related to three airline operator types. Finally, cost effectiveness and utilization of unit load devices (ULDs) were established to complete the study on the existing infrastructure.

Current Airport Capacity and Constraints

The airport complex is composed of many elements which collectively establish its operational capacity. From the airside, the complex must be capable of efficiently handling varying sizes of aircraft and numbers of aircraft arrivals and departures around the clock or during specified hours. Airport elements which determine this capacity are flight- and ground-control systems, runway and taxiway design and maintenance parameters, ramp and gate provisioning, plus service and maintenance capabilities. From the landside, the complex must have facilities and processing systems which are capable of effecting a time-phased transfer of cargo and passengers between air and surface vehicles. Airside and landside capacities must be balanced over the long run to achieve full benefit from the complex. The airport complex is faced with political, environmental, and economic decisions which reflect on its technical capacity.

Airport survey rationale. - Airports selected for study were Los Angeles International Airport (LAX), J. F. Kennedy International Airport (JFK), Atlanta William Hartsfield International Airport (ATL), Chicago O'Hare International Airport (ORD), and Detroit Metropolitan Wayne County Airport (DTW). These airports represent established cargo-processing centers covering a range of flow levels, growth potential, operational demands, and site development maturity. JFK and LAX are major origin-destination points on the east and west coasts for domestic cargo movement. JFK is the major hub for international traffic. ORD is the major domestic transfer hub and, like LAX, is gaining stature as an international cargo center. Air cargo operations for the growing southeastern section of the country are concentrated at ATL. DTW is located in the heart of the automotive industry, and operations reflect the cyclical nature of that business. Both ATL and DTW possess the latent potential for significant future growth, particularly for international operations. Several other airports were also considered for the study, but survey constraints precluded additional coverage. Table 3-1 provides the relative cargo and passenger flow ranking of the surveyed airports.

TABLE 3-1
1976 AIRPORT PASSENGER AND CARGO FLOW RANKING

Airport	Passenger Flow*	Total Rank	Cargo Flow**	Total Rank
LAX	9.791	3	699	3
JFK	6.933	5	1089	1
ATL	13.307	2	335	6
ORD	17.241	1	751	2
DTW	3.875	10	180	11

*Passengers X 10^6 enplanements (CAB statistics - 1976)
**Kg X 10^6

Prior to the survey, pertinent available data on the subject airports were reviewed to determine what supplemental information would be required from the airport authorities to conduct the study. These data, usually current master plans, were requested from the airport authorities, and appointments were established with key personnel to discuss present and future airport capacity constraints. Interviews were held in conjunction with the cargo terminal surveys at each airport. The survey team concluded that airline cargo terminal management and airport authority personnel were generally well informed of the objectives and realities of the air cargo environment at the airport. The authors wish to express their gratitude to the following individuals for their cooperation and open discussions.

LAX - William M. Schoenfeld - A.I.A.
Jack Graham - Airport Facilities Planner

JFK - Allen Haack - Supervisor Airport Planning

ATL - Maxwell Walker - Director Airport Planning

ORD - John Carr - Airport Manager

DTW - Chuck Van Deusen - Assistant Managing Director
Daniel Norton - DTW Airport Supervisor
Robert Larson - Director of Transportation

The airports included in this study provide a good cross section of airports deeply involved in air cargo operations. Within the scope of this study, they will continue to be major centers. Are they representative of other major air cargo centers? Individually, they probably are not. However, overall they do have the same problems and objectives encountered by other major air cargo centers.

Air cargo throughput. - In the past, the air cargo industry has been expanding at a much faster rate than most sectors of the economy. But air cargo's expansion is very much sensitive to outside pressure. Typically, as money tightens and business suffers, so does the air cargo industry. This is primarily the result of two factors, namely, (1) there are fewer items to ship during hard times as business volumes will decrease and, (2) customers may prefer to economize and transport items via a less expensive mode of transportation. The second factor is minor since the most critical incentive to ship by air appears to be time savings rather than cost savings.

The rate of growth of the air cargo industry at the five study airports has been phenomenal. The rate of growth declined significantly in the economic slump of the 1970s; however, with a stabilization of the economy and with the current upward turn in the business cycle, a general upward trend should continue. Table 3-2 illustrates the air cargo growth at four of the five airports. No trend data were obtained from Chicago.

Each airport that was surveyed had differences in total flow composition. The New York (JFK) air cargo flow was basically international, accounting for 62 percent of the total. Of the international flow, approximately 51 percent was shipped on all-freighter aircraft with the remainder shipped on passenger aircraft. With the future trend of more wide-body passenger aircraft flying international routes, this percentage will change to emphasize the increased aircraft cargo volumes. All-freighter aircraft are particularly important in the movement of domestic freight.

TABLE 3-2

AIRPORT AIR CARGO GROWTH

Year	7 Year Throughput Trend (Kg X 10^6)				
	JFK	LAX	ATL	DTW	ORD
1970	868	473	311	-	-
1971	919	515	313	-	-
1972	1014	595	344	166	-
1973	1121	654	338	224	-
1974	1085	673	333	212	-
1975	1025	649	311	159	-
1976	1089	699	335	180	751

In the referenced time frame, all-freighter aircraft accounted for about three-fourths of the total domestic tonnage. Another characteristic of JFK air cargo is that both domestic and international transfer cargo accounted for about 36 percent of the total traffic volume. Domestic transfers represent 39 percent of the total tonnage of which 81 percent was between aircraft. The remaining 19 percent of domestic transfer is from truck transportation for movement to and from outlying areas of New York. Major airlines at JFK are American, United, Flying Tiger Line, Seaboard World, Pan American, Lufthansa, and Airlift International.

The Chicago airfreight characteristics are opposite those of New York in that it handles more domestic than international cargo. The 1976 flow throughput was 751 million kilograms of which domestic freight accounted for 85 percent, or approximately 639 million kilograms. Typically, a majority of the Chicago flow is handled by a few airlines. The top four airlines at ORD accounted for nearly 62 percent of the throughput, or 452 million kilograms. United Airlines with 236 million kilograms, accounted for 31.5 percent of the total volume, or more than the second through fourth place (American, TWA, and Flying Tiger Line) volume leaders combined. No information could be obtained which could give some insight as to the amount of freight that is shipped by all-freighter aircraft, belly-pit-only operators, or the amount of freight that is transfer freight - both online and interline.

Similar to ORD, four airlines (United, American, TWA, and Continental) handled more than 53 percent of the throughput cargo flow at LAX in 1976. The top 15 airlines handled approximately 91 percent of the cargo flow with the remaining 23 airlines and air-taxi operators accounting for slightly less than 9 percent of the throughput. The airline data obtained from the airport authority did not segregate domestic and international freight and originating/terminating and transfer freight.

At ATL, approximately 90 percent (301.5 million kg) of the 1976 cargo throughput was carried in the belly pits of passenger aircraft. Most of the remaining 10 percent was handled by Airlift International in DC-8 freighter aircraft. Major belly-pit operators include Eastern Airlines (which handles approximately 21 percent of the total tonnage at ATL, both domestic and international), Delta Airlines (45 percent of total flow), and Northwest Orient. International cargo currently accounts for 0.2 percent of the tonnage and, at this time, is handled only by Eastern. No data relative to past trends in transfer freight could be obtained from the airport authority. But in their future forecast of airfreight, transfer freight is projected to account for more than 40 percent of the total throughput tonnage.

Approximately 69 percent of the 1976 cargo flow at DTW was handled by four airlines (American, United, Northwest, and Delta). The remaining 13 airlines and two air taxi operators accounted for the remaining 31 percent. The throughput flow data were by aggregate airline and did not break out the data by all-freighter volumes versus belly-pit volumes or by origin/destination versus transfer freight.

The airfreight movement at Detroit more or less follows the country's economic trends since it is very sensitive to the handling of automotive cargo. The intensity in handling auto freight is depicted by the movement at Detroit's Willow Run Airport. In 1976, the three supplemental airlines operating out of Willow Run (Auto Air, Zantop, and ONA) handled 62.7 million kilograms, or approximately 35 percent of the freight movement from Detroit's Metropolitan Wayne County Airport. These data along with the other airport statistics were obtained from the airport authority.

Future air cargo forecasts through the year 1990 are presented on Figure 3-1 for each of the five study airports. The top three airports (JFK, ORD, and LAX) are projecting future air cargo growth at about 8 percent annually. Atlanta is forecasting a growth rate of 10 percent, while Detroit is forecasting a 10 to 15 percent growth rate.

Many of the airport authorities were hesitant to estimate any future growth rate because of the many uncertainties and intangibles involved in putting together the various aspects of econometric change. As an example, the forecast of future growth at Detroit is very sensitive to the automotive industry. With a continued boom in the manufacturing of autos, airfreight will also exhibit strong growth. Freight related to the automotive industry

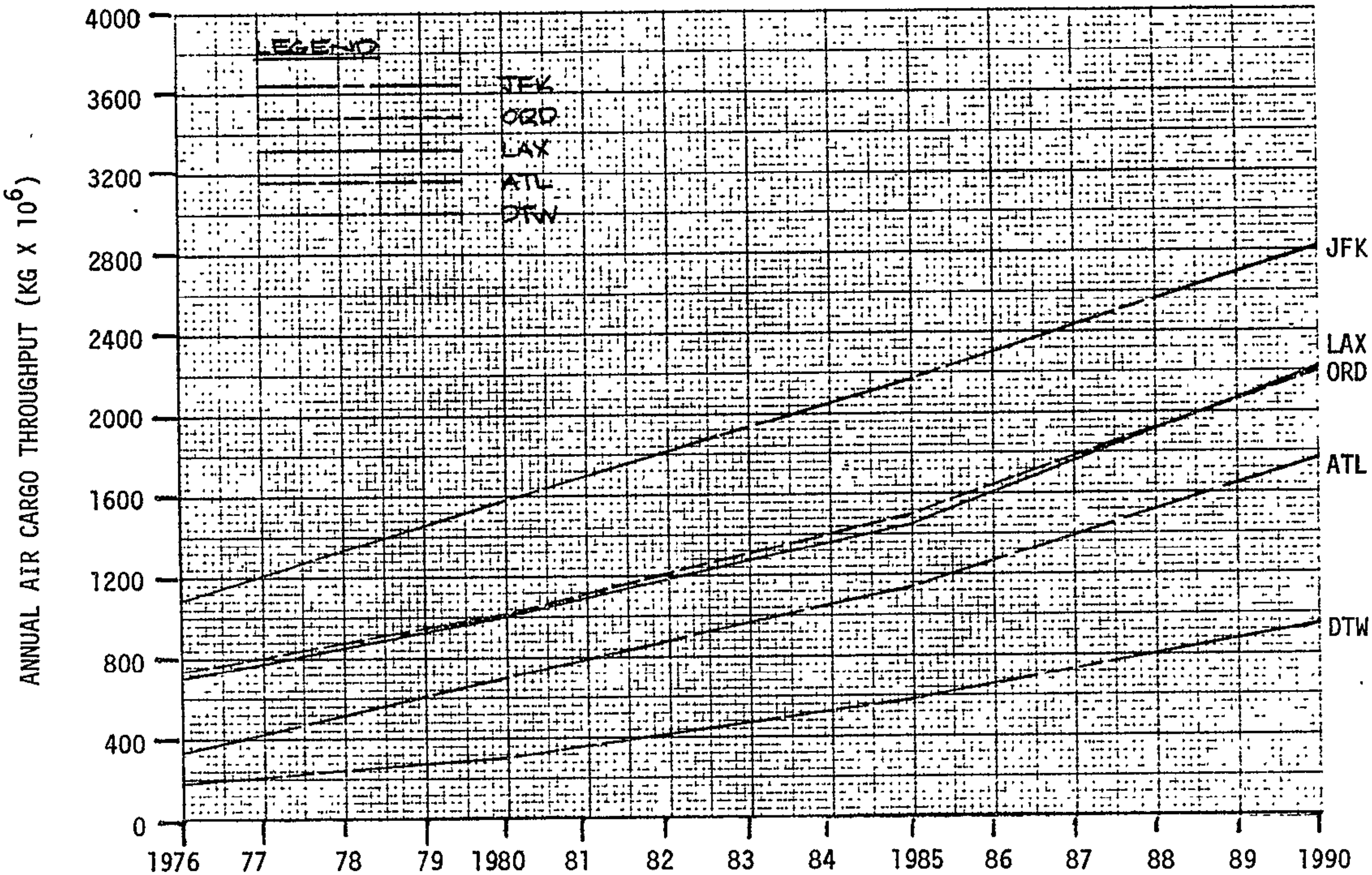

Figure 3-1. Air Cargo Forecast - 1976 to 1990

accounted for 75-80 percent of the outbound flow for one airline at DTW. The 10-15 percent growth rate in the latest master plan for DTW was deemed to be optimistic but potentially achievable.

With increasing industrial activity in the southeastern area of the country, the forecast growth rate of 10 percent for ATL may be too conservative. Growth at Atlanta is contingent on several factors:

- Anticipated increase in mail volume
- Expanded European air cargo market due to a pending route award of a London - Atlanta segment
- Expanded South American air cargo market due to a pending route award

These growth factors were discussed with the airport authority during the interview and survey phase of the study in Atlanta.

Airport capacity and constraints assessment. - The airports selected for study have different capabilities since they have been developed to meet particular requirements for the locale they service. While some constraints are common to all five locations, the problems faced by each airport are different. Capacity and constraints for each complex will be discussed in total and then specifically related to air cargo operations. This approach will provide a sound definition of the surveyed complexes and permit identification of basic trends in air cargo capabilities and constraints.

Los Angeles International Airport: As shown in Figure 3-2, the runway configuration at LAX consists of two pairs of parallel runways with east-west orientation that border the north and south boundaries of the airport. The passenger terminal complex is located between the runway pairs and consists of six satellite terminals. Maintenance and fuel storage facilities are located between the runway pairs in the western sector of the airport. Cargo City is located in the northeast sector of the airport which is bounded by Century and Aviation Boulevards. (See Figure 3-3.) On the southern boundary of the airport along Imperial Highway, there are several additional cargo

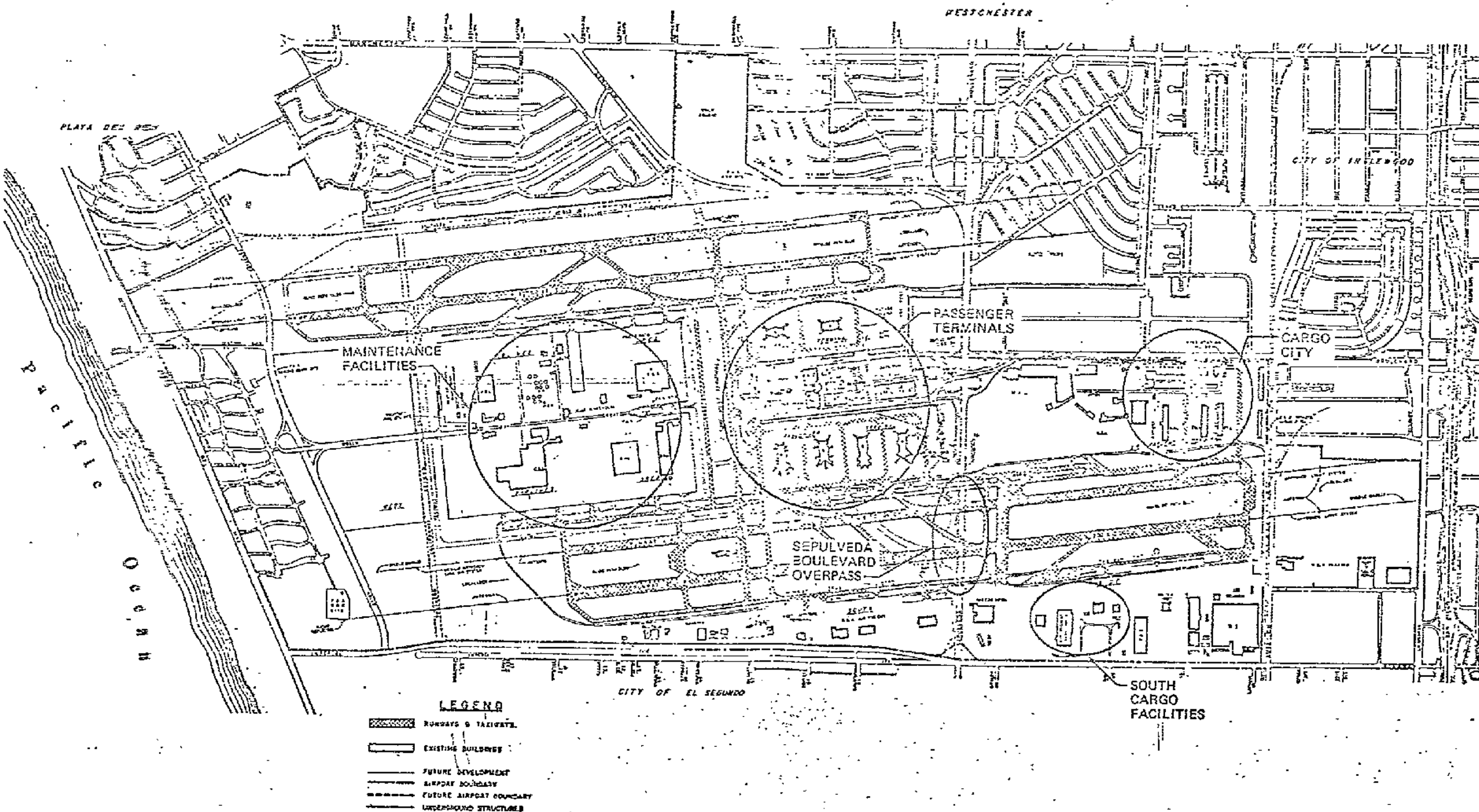

Figure 3-2. Los Angeles International Airport

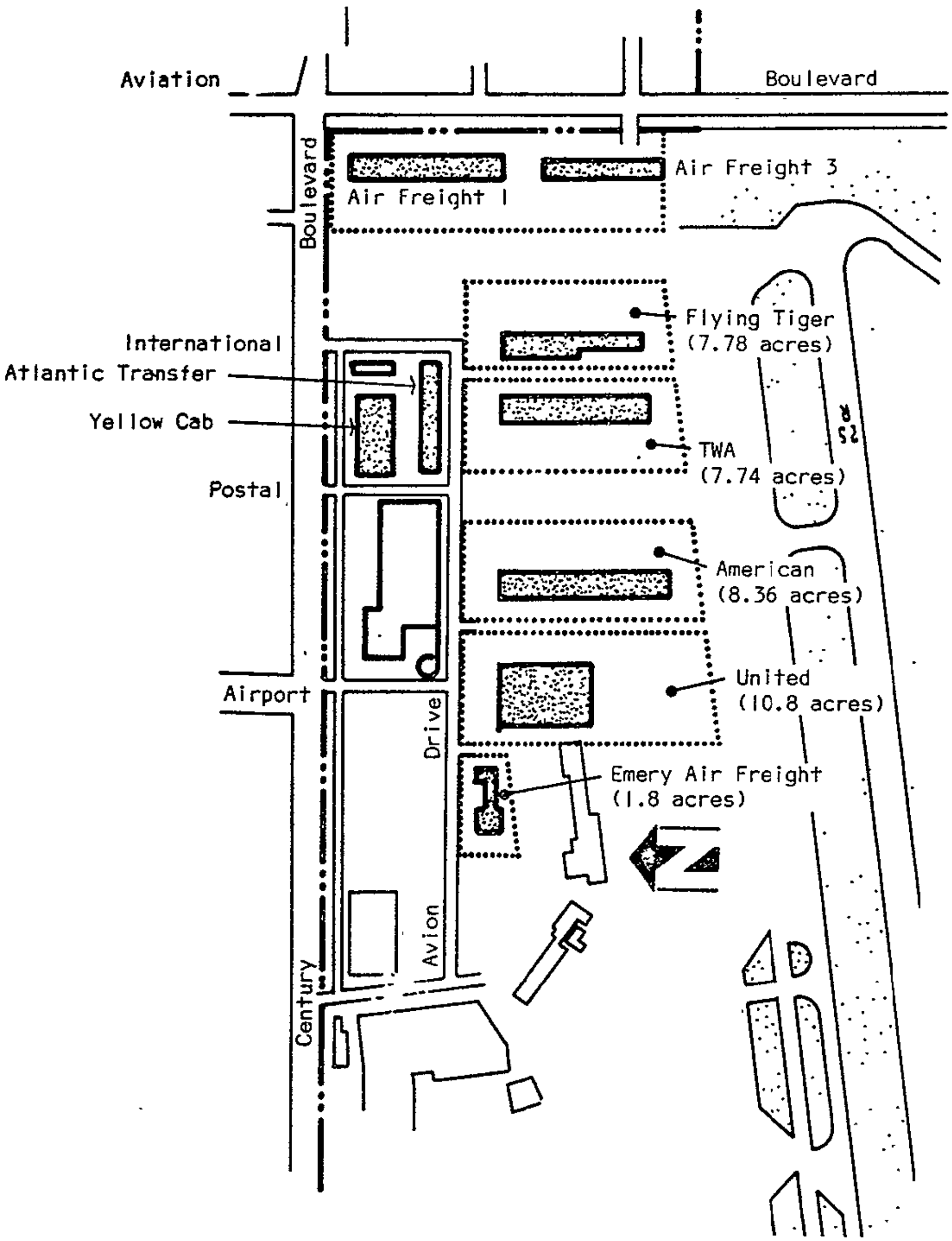

Figure 3-3. Current LAX Cargo City Facilities

terminals as well as hangars, industrial sites, and a passenger terminal for charter operations. Principal access routes for passenger traffic are on Century and Sepulveda Boulevards. Cargo traffic is concentrated on Century and Aviation Boulevards with Imperial Highway being utilized to a lesser degree.

LAX has sufficient runway capacity to handle future air carrier demand. Current demand for runway utilization is approximately 400 000 air carrier movements, or about 50 percent of the annual runway capacity. Standard usage is an all-westbound operation on runway pairs 24 and 25 with arrivals usually on the outer runways, especially during IFR conditions. Since the airport is bounded on three sides by light industry and residential areas, landing approaches are required from the west over the ocean from 2400 to 0630 hours. However, LAX is a 24-hour airport. The Sepulveda Boulevard overpass structure imposes a weight restriction of 147 418 kilograms on the southern pair of runways and taxiways. Most wide-body aircraft, therefore, are forced to use the northern pair of runways.

Landside access/egress will be the major constraint to fulfilling future passenger enplanements. Ground access demand was 28 million passengers in 1976, while ultimate service capacity has been estimated to be 30 million annual passengers on the main access route, Century Boulevard. The groundside access problem is being studied for LAX.[5] Options include new freeways, remote parking with mass transportation, and increased use of Ontario Airport. Truck congestion on the Cargo City service roads becomes particularly acute at Buildings 1 and 3 during prime time operations. There is no present solution for this problem.

Cargo City has separate terminal facilities for United, Flying Tiger Line, American, and TWA. Each terminal has ramp positions for four narrow-body freighter aircraft. Freight Buildings 1 and 3 house tenants such as Continental, Delta, PSA, Northwest, Western, and Hughes Air West. Due to near capacity conditions at these buildings, only one of eight ramp positions is being used for DC-8/B707 freighter operations. Much of the ramp area is used for ULD storage, staging, and buildup/breakdown activities. Airlift

International, Pan American, Korean, and Japan Airlines are the principal operators using converted hangars for cargo operations on the south side of the airport. There are four ramp positions on the south side for narrow-body freighters and one for wide-body freighters. The latter is located west of Sepulveda Boulevard. (See Figure 3-4.)

The Sepulveda Boulevard overpass restriction precludes the use of wide-body freighters at Cargo City and at most of the south side terminals. American Airlines and Flying Tiger Line are handling B747 freighters near their respective maintenance facilities on the west end of the airport. Korean Airlines uses a ramp just west of Sepulveda. Remote handling of these freighters is time consuming and costly, particularly for the operators from Cargo City. First, the ramp crews are split from the normal operations at the terminal. Second, transportation time of approximately 15 minutes one way must be added to cutoff times at the terminal. Only four standard ULDs can be transported by a single truck-trailer which is compatible with service road traffic. If the weight restriction is increased to 680 000 kilograms as planned for the taxiways and runways, the compatibility of B747 freighters at Cargo City would be marginal due to the physical constraints imposed by the facilities. American Airlines and Flying Tiger Line could position one B747 freighter each, while United Airlines could position approximately eight using their cargo terminal and maintenance facility ramps. With only the taxiway on the south side strengthened, there could be congestion at the end of the runway when freighters try to gain access to Cargo City and run counter to outbound passenger flights.

The key to cargo growth at LAX is the environmental issue. Environmentalists have more or less restricted growth at the airport. A typical example is the delay encountered to strengthen the Sepulveda tunnel. According to the airport authority, plans for rebuilding the tunnel have existed since 1969. Due to pressure from environmentalists and local politicians, the project has not commenced. The current estimate now is for a 3-1/2-year completion period which includes 1-1/2 years for approval of the EIR (Environmental Impact Report), 1/2 year for redesign, and 1-1/2 years for construction. Another environmental problem concerns the future of airport

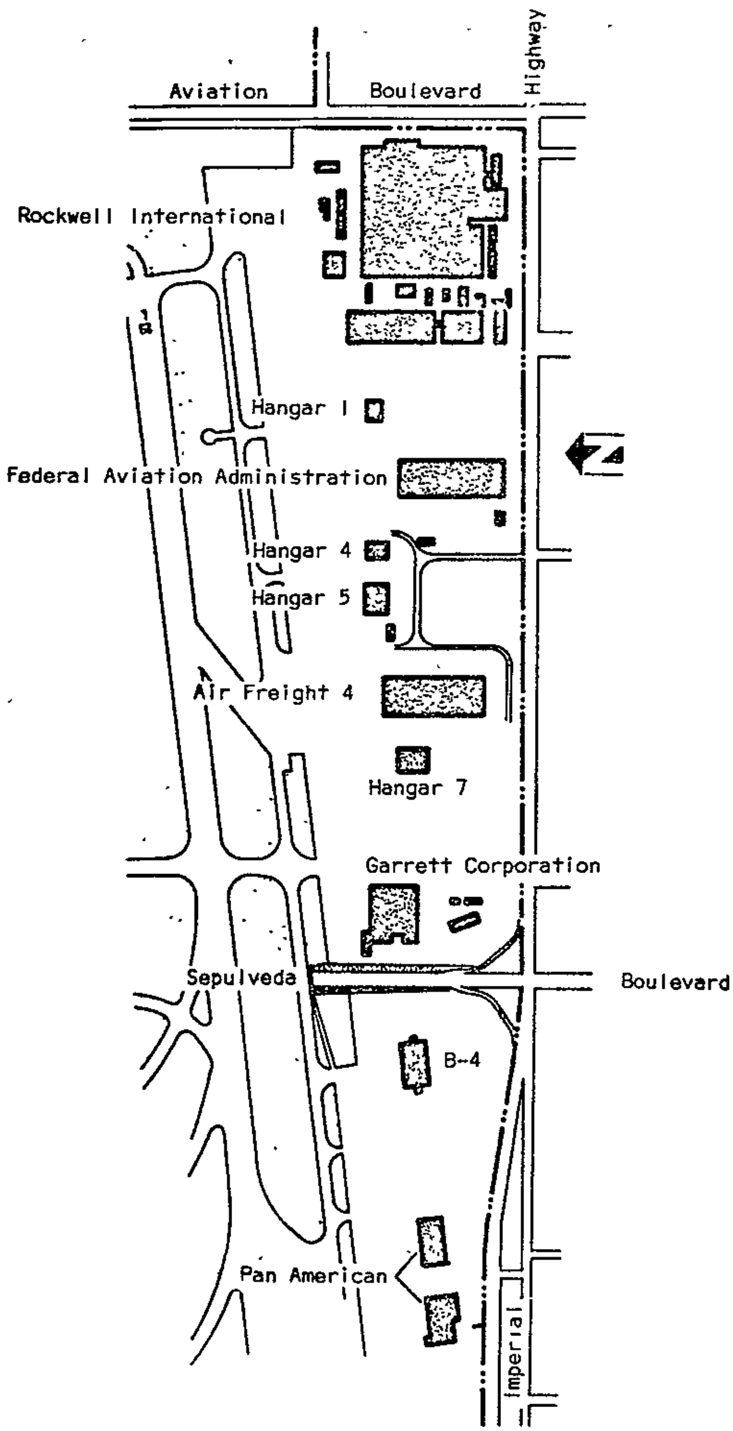

Figure 3-4. Current LAX Southside Cargo Facilities

expansion along the western boundary of the airport. The newly created Coastal Commission plus a group organized to save the El Segundo blue butterfly are potential road blocks. There also appears to be growing concern over the truck traffic in the airport areas which is allegedly generated by air cargo operations. However, truck traffic will always be present in an area of business and light industry; air cargo traffic is not necessarily going to create more congestion due to its operational time periods and more load per vehicle due to the trend towards consignor loaded containers (CLCs). Finally, night freighter operations are seen as a prime source of noise pollution, although the number of freighter aircraft is quite small and landing approaches must be over the ocean after midnight.

The maximum capacity of existing cargo facilities at LAX is 1 million tonnes per year. Based on the future airport projections in Figure 3-1, the airport facilities should be saturated in 1980, or slightly later if increased use of CLCs is achieved and if increased frequency of daylight operations can be realized. Preliminary expansion plans for LAX involve major cargo facilities along the south side, as illustrated in Figure 3-5, in which case Cargo City might be used primarily for belly-pit operators.

The LAX air cargo master plan describes near-term as well as long-term solutions to handle the projected demand of freight. The near-term solutions are as follows:

- Reinforce the Sepulveda tunnel
- Extend Airfreight Building 1 four to five bays
- Construct a new airfreight facility west of existing Airfreight Building 1.
- Encourage Cargo City tenants to further increase the use of cargo bypass systems, mechanize their facilities, plus expand the existing warehouse terminals
- Expand the Flying Tiger Line, American and TWA facilities

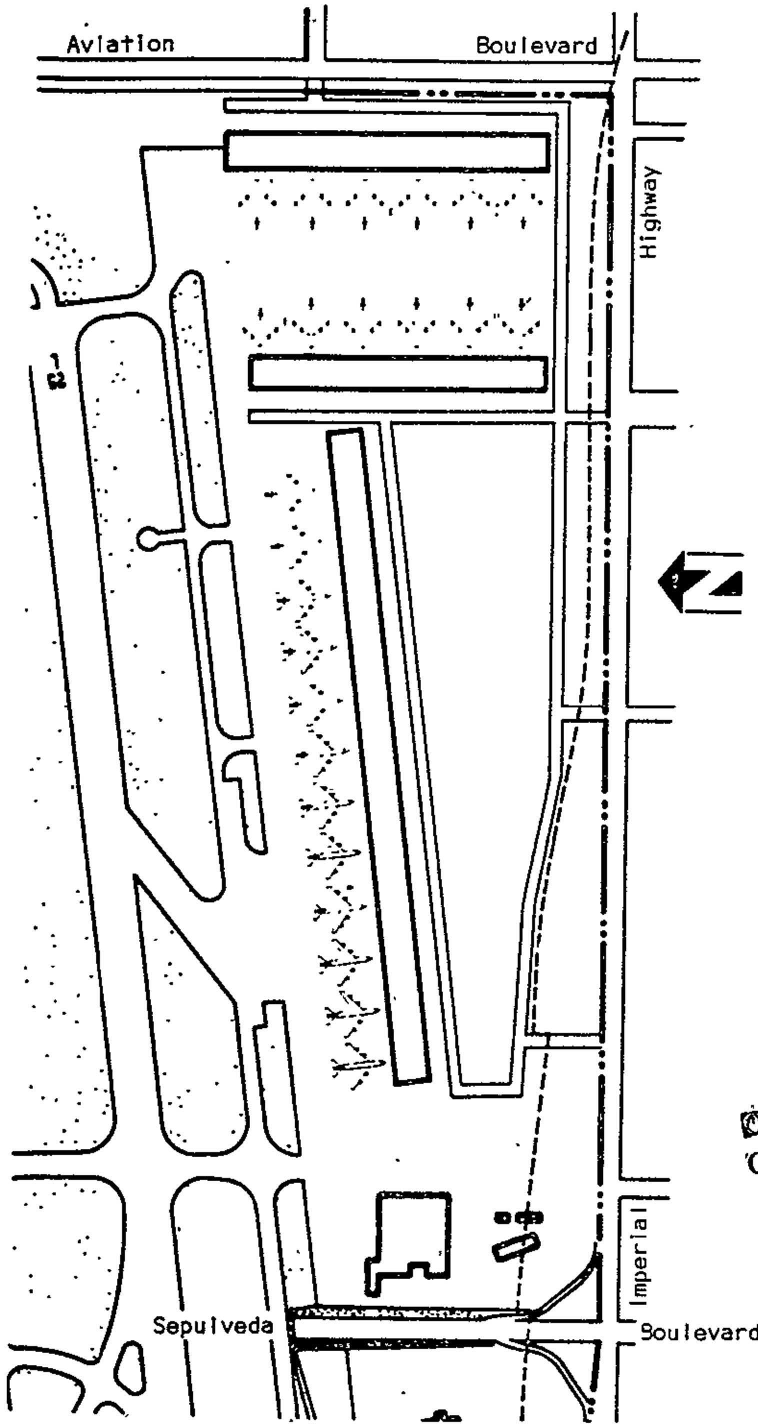

Figure 3-5. LAX Future Cargo Facilities - Southside

To handle the long-range projections for air cargo, additional facilities must be built to handle the flow. Three areas are considered for future development, but the most logical area for initial development would be the south side of the airport along Imperial Highway between Sepulveda and Aviation. The other two sites, the west side along Pershing Drive and the north side show great promise in that they are presently undeveloped. However, both areas will require substantial capital to develop and face zoning problems that may take considerable time to resolve. The master plan of the south side is shown on Figure 3-2. Current plans call for 77 690 square meters of warehouse space allocated to three buildings. The parallel building to the runways will have frontal area for 11 B747 aircraft parked parallel to the building. The two other smaller buildings will have 10 B747 positions and one DC-8 position.

The movement of the cargo operators to the south side will also be confronted with a ground-access problem. Currently, Imperial Highway is saturated with airport-related and private industry traffic during the peak hours. Additional traffic generated by the cargo facilities would cause a huge amount of additional surface delays. The master plan for ground transportation calls for the 105 Freeway to be constructed parallel to the Imperial Highway right of way from Sepulveda to the east. Imperial Highway west of this point will be widened to handle the anticipated level of traffic. The movement of the facilities to the south side will cause some problems to the freight forwarders who are now located in close proximity to the existing Cargo City area. Split operations of two facilities will lengthen delivery times for outbound freight, or it will call for additional trucks and manpower to run two separate loops to both Cargo City and the new south facilities.

<u>J. F. Kennedy International Airport</u>: - The runway layout at JFK consists of two sets of parallel runways and one short runway as shown in Figure 3-6. Runway pair 13/31 are separated by more than 1500 meters and run east-west. Runway pair 4/22 are separated by nearly 900 meters and run north-south. The passenger terminal complex is located west of the 4/22 runways and between 13R/31L and 13L/31R and consists of nine separate terminal buildings. Maintenance facilities are located west of the passenger terminals primarily along runway 13R/31L.

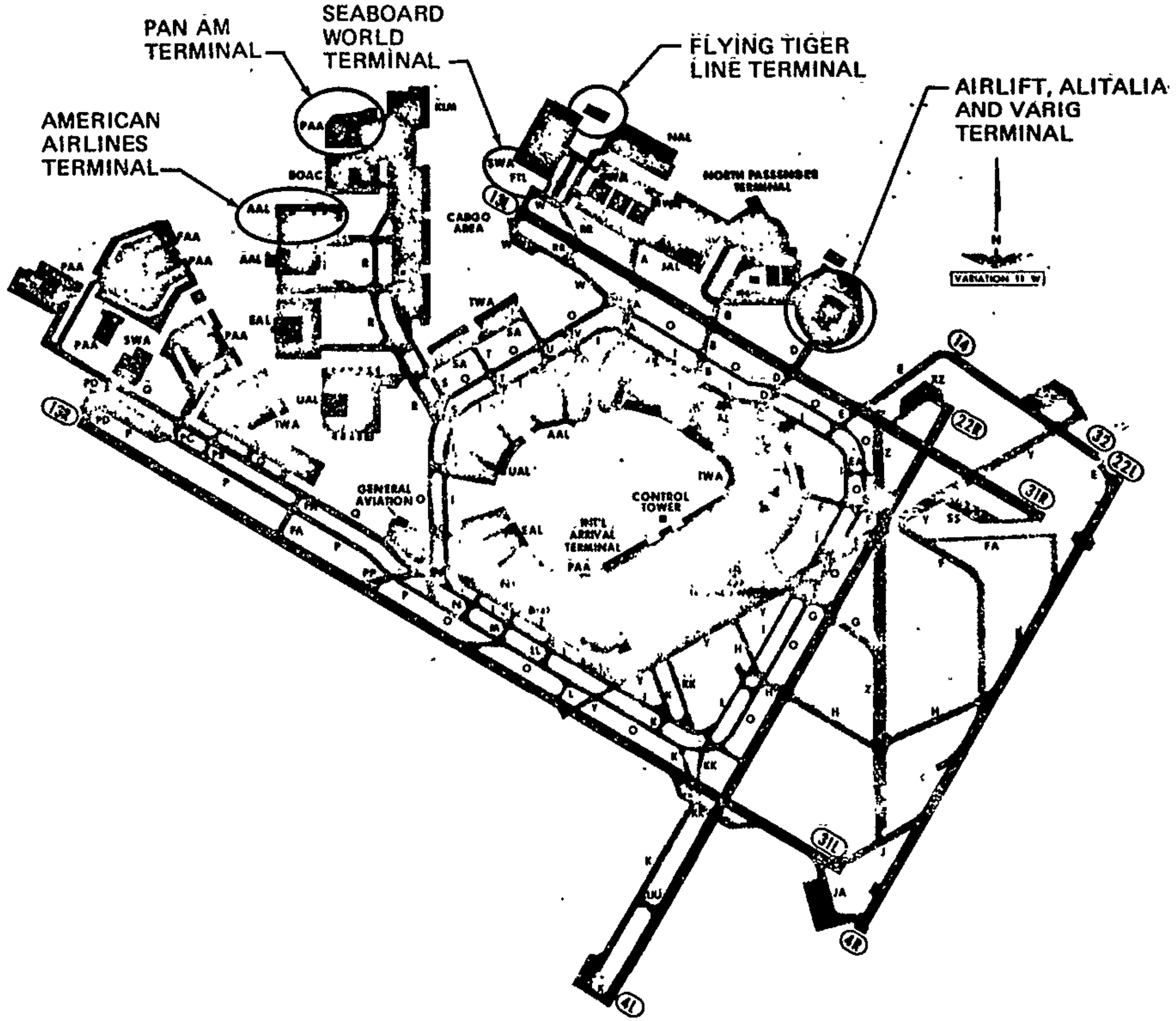

Figure 3-6. New York JFK International Airport Layout

The cargo terminals are located from 1.8 to 2.2 kilometers from the passenger terminal complex on the north and west sides of the airport respectively. There are currently three access routes into JFK. The main access route is on the Van Wyck Expressway with 150th Street and Rockaway Boulevard serving as secondary routes for passenger traffic. The latter two routes are utilized for cargo traffic. A new entrance off Rockaway Boulevard on the east side of the airport will also be primarily used for cargo movements and should eliminate any access/egress congestion problems for the foreseeable future.

Overall runway capacity at JFK is somewhat difficult to analyze because of the varying noise, wind, and runway usage parameters that exist. Runway utilization depends somewhat on evenly distributing noise exposure in the heavily populated area surrounding the airport. Under this constraint, the runway configuration is changed every 8 hours, providing that the wind does not exceed 15 knots and the runways are considered clear and dry. During IFR conditions, the runway pair 13/31 can be operated independently, one for arrivals and one for departures. When this occurs, the computed hourly acceptance capability is 74 operations. When either 4 or 22 is used, the resulting hourly acceptance is 54 operations. If the operations are staggered to both runways and just one is used for departures, the computed capacity is 64. During VFR conditions, the computed runway capacity for either pair of parallels is about 83 operations.

At JFK from 1500 to 1900 hours, a quota system is in effect for each class of aircraft. The quota between 1500 and 1700 hours is 70 air carrier operations, five scheduled air taxi operations, and five operations for all other users. From 1701 to 1900 hours, the air carrier quota is increased to 80 while the other quotas remain the same. The increased air carrier level is due to the demand of departures during this time frame.

The cargo terminals at JFK are dispersed throughout the west and north access roads leading into the passenger terminal areas. From Figure 3-6, the major terminals located off the Van Wyck Expressway on the west side of the airport are Pan American World Airways and American Airlines. On North

Boundary Road are located the Flying Tiger Line terminal and the terminal shared by Airlift International, Alitalia, and Varig Airlines. The terminal operated by Seaboard World is located east of the 150th Street airport entrance. The airport authority has not developed a master plan for future cargo facilities only because additional cargo facilities are not required in the near future. From the five terminals surveyed at JFK, it appears that the facilities, on the average, are at 80 percent of total capacity. At the projected 8-percent growth through the study time frame of 1990, the current terminals will become saturated in the early 1980s.

The ramp facilities at JFK are more than adequate to handle current B707 and DC-8 all-freighter aircraft. Many of the terminals currently handle B747 freighter aircraft but are limited in the number of aircraft that can be handled simultaneously due to the size of the ramp and associated taxiways. As an example, Seaboard World can handle a B747 with a nose-in attitude only if the Lufthansa German Airlines B747 is not parked in its ramp position opposite the Seaboard terminal. Otherwise, it must park in a power-in/ power-out mode due to the lack of adequate wing tip clearance of maneuvering aircraft on the taxiway between the two cargo terminals. The American Airlines facility was originally designed to handle the B707 freighter with their fixed-dock, forward side door Astro-loader handling system. Currently, two B747F aircraft can be handled simultaneously but would tax the in-terminal and ramp facilities because of the number of containers that must be handled. The Flying Tiger Line and Pan American also handle the B747F without any physical constraints due to ramp space or taxiway clearance. Pan American has completed plans to upgrade the pavement strength of the ramp hard stands such that all five can handle the increased weight of the B747F.

The airport authority indicated that there are basically no constraints at JFK on either the landside or the airside. A major constraint which may hinder the growth of air cargo is the financial condition of the airlines. Lack of sufficient capital to expand operations is the main factor. Additional cargo-handling capacity can be achieved through either expansion of existing terminal floor plans and ramp areas or through varying degrees of mechanization such as stacker systems. Added capacity could also be achieved by using available hangars and other airport buildings. The service roads to these buildings are completed.

Once the current facilities become saturated, JFK does have room to expand. There is a large tract of undeveloped land to the east of runway 4R/22L. This area would be ideal for a pure all-freighter operator since it is away from the passenger terminal complex and its related activities. This site might not be acceptable for belly-pit operators since the cargo trains would have to cross two active runways plus traverse approximately 3 miles to reach the passenger terminal. These two problems would be detrimental to overall airport capacity. Finally, there is sufficient area around the perimeter of the airport for offsite cargo terminals. Just north of Rockaway Boulevard, the city is proposing an industrial park which would be an ideal location for offsite cargo terminals.

The quota system which limits aircraft arrivals and departures between 1500 and 1900 hours could constrain international cargo growth. This is not a prime time for domestic cargo operations. However, there are 79 international passenger flights and nine cargo flights arriving or departing during this time. The quota system will tend to force the substitution of larger aircraft for smaller aircraft.

Aircraft noise is the major environmental issue at JFK. The current major problem evolves around the Concorde SST and its landing rights at JFK. Once that issue is resolved, it is hard to say what the next issue will be. On-airport construction of facilities has not encountered much opposition. However, JFK voluntarily eliminated a plan to extend runway 4L into Jamaica Bay several years ago when its own study found the extension would be harmful to the environment.

In terms of existing cargo facilities, the results of the onsite surveys plus the future growth rate of air cargo are that the existing facilities will become saturated in the early 1980 time frame. But additional cargo facility capacity can be achieved through expansion of existing facilities and/or with varying degrees of mechanization such as stacker systems. Also, capacity can be achieved through the use of available hangars and other buildings. For the 1990 time period, it is anticipated that there will be sufficient cargo landside facilities to handle the projected demand.

On the airside, the quota capacity system only occurs between 1500 and 1900 hours. The other operating hours are not restricted in this manner and are capable of handling other all-freighter aircraft or additional passenger aircraft. If JFK does become runway capacity limited in the 1990 time frame, flights can be diverted to LaGuardia and Newark. This may present a problem in the logistics handling of freight, especially transfer freight. This problem is being handled currently by many domestic airlines who now operate into multiple airports in the New York area, especially American Airlines. Also, for additional airside capacity in terms of new airports, the old Stewart Air Force Base complex is now operated by the Metropolitan Transit District and has very low priority relative to upgrading the facility to handle either air carrier traffic or airfreight traffic.

Atlanta William Hartsfield International Airport: - The three principal runways at Atlanta are the three parallel runways 9L/27R, 9R/27L and 8/26 as illustrated on Figure 3-7. Runway 15/33 handles a relatively small number of operations while 3/21 is used primarily as a taxiway. Under east-west operations, the 9/27 runway pair is used in a dual-lane concept and 8/26 is operated in a mixed-mode concept. The distance between 9R/27L and 8/26 is 1341 meters and between 9L/27R and 9R/27L is 320 meters. The current airport terminal building is located north of the three-runway complex. The location of the passenger terminal requires that all aircraft using the 9/27 runway pair must cross an active runway (8/26). This reduces the effective capacity of the airport.

During VFR conditions and with the direction of traffic in a westerly to easterly flow, the maximum hourly capacity on the runway system is 125 operations. With IFR conditions, the effective runway hourly capacity is reduced to 105 operations. A major problem at Atlanta is the intrahour scheduling peak. A breakdown of a typical peak hour into quarterly segments

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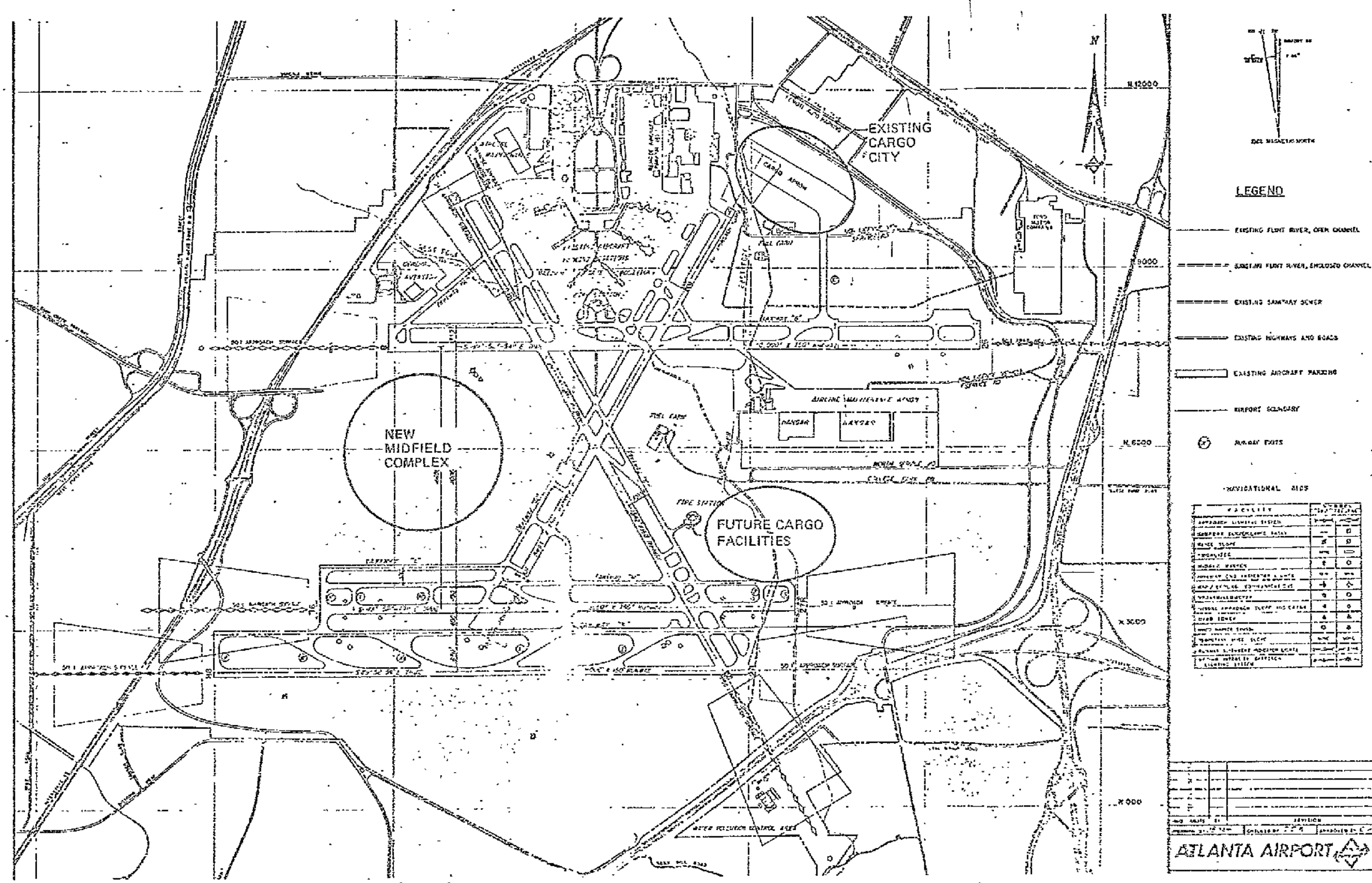

Figure 3-7. Atlanta International Airport

yields a percentage distribution of 37 percent, 23 percent, 16 percent and 24 percent. Thus, 60 percent of the hourly traffic is scheduled during the first half hour. These schedule peaks cause traffic congestion and result in excessive ground delays.

Delays are also caused by the current runway volume-to-capacity ratio. The peak hour demand at Atlanta is 99 operations between 1600 and 1700 hours, which is 94.3 percent of the IFR maximum runway capacity. Excessive ground delays can be expected with this ratio (V/C) approaching unity.

Additional runway capacity at Atlanta will be achieved with the new midfield passenger terminal concept which is under construction. With the terminal located between the two 9/27 runways and runway 8/26. This terminal concept will increase runway capacity by 9.5 percent to 115 operations under IFR conditions. The first phase of the midfield terminal should be completed by 1981.

The airport authority also indicated that an additional fourth parallel runway will be constructed by the 1990 time frame. This will increase the IFR runway capacity from 115 to 150 operations. More efficient air traffic control procedures and equipment will be available to accommodate the additional capacity and will help the growth of air cargo at Atlanta. The airport should not be a constraining factor. This is especially true if the potential growth occurs primarily in terms of wide-body, belly-pit operations since the airport does have the capacity to expand with the future runway configuration.

ATL currently has 72 gates set aside for use by individual airlines. During peak periods, the high demand for gates causes some delay. Eastern Airlines is now using some remote parking spots with mobile lounges used to transport passengers to and from the terminal. The new midfield terminal is scheduled to provide 104 gates by 1981 and a total of 128 gates by 1990. As the new terminal is completed, the present terminal will be used primarily for general aviation activities.

External airport ground access will become a serious problem in the near future. Basically, there is one major entrance to the airport off Virginia Avenue from Interstate 85. The main surface street is two lanes of flow in each direction. During the peak period, Virginia Avenue is normally congested with both airport- and nonairport-related traffic. Virginia Avenue also feeds the major cargo terminals from I-85, but several kilometers past the passengers terminals. The cargo terminals also have access from near the intersection of I-75/I-285. When the new midfield passenger terminal becomes operational, passenger access will be provided from I-85, approximately 3 kilometers from the current airport entrance.

Atlanta Airport functions primarily in a belly-pit cargo mode with 90 percent of the existing throughput flow being transported in passenger aircraft. Total projections in annual air carrier operations are expected to increase by about 50 percent in the 1985 time frame. By then, the percentage of wide-body aircraft is expected to increase five fold from about 10 percent of the total operations to 50 percent of all operations. Cargo transportation in these aircraft will generate a considerable amount of ground vehicular traffic, thus adding to the current congestion in airport surface traffic flow. The existing passenger and cargo terminals are 1.5 kilometers apart and served by a two-lane access road which requires 6 minutes for a one-way trip. The midfield terminal will be 3 kilometers from the existing cargo terminal complex. Means of circumventing the runways must be provided relative to both the existing and future cargo facilties.

With the exception of Eastern Airlines cargo terminal, which is located on the west side of the airport close to the passenger terminal, cargo activities are concentrated on the north side of the airport. The current north cargo complex is only two-thirds occupied with freight forwarders and airline tenants. The major operators are Delta and Airlift International. The frontal area along the ramp is approximately 823 meters and can accommodate 12 B747 all-freighter aircraft in a nose-in tow-out parking mode. This building, however, is less than optimum for air cargo operations due to limited height clearance at the truck docks and limited access to the aircraft ramp. Once these facilities become saturated, a new cargo complex located on the south side will become operational in the early 1980 time frame. This complex will eventually accommodate 25 narrow-body and 11 wide-body aircraft simultaneously. These cargo processing facilities are considered to be adequate to meet requirements into the 1990s.

Similar to many major airports, Atlanta is currently encountering problems with environmentalists relative to the implementation of environmental impact reports for new construction programs. The new midfield terminal project is under construction without too much outside pressure. Atlanta is currently curfew free with aircraft operations around the clock. The Atlanta airport authority expressed some difficulty in predicting whether curfews will be applicable in the future. It may be that aircraft with high-noise characteristics could be limited in the number of operations into and out of the airport. This is critical for older all-freighter aircraft like the DC-8 and the B707. Curfews may not be required if airport neighbors realize that newer, more quiet aircraft are being phased in on a regular basis.

Chicago O'Hare International Airport: - The Chicago O'Hare runway and terminal building layout is presented on Figure 3-8. The passenger terminal building is centrally located amid the three sets of parallel runways that are used for jet operations. A shorter north-south general aviation runway (18/36) is located north of the terminal complex. All three sets of runways are separated at least 1524 meters apart and are capable of independent operation. The O'Hare complex is essentially operated as two separate airports. The normal procedure is to operate the runways south of the terminal independently of the northern runways. Each complex of runways has its own separate controllers handling operations. Normally two runways are utilized in each complex, one for arrivals and one for departures. By operating two facilities, ORD is able to support an hourly runway capacity of 150 operations under VFR conditions. During IFR conditions, the runway capacity is reduced to 120 operations. VFR conditions at ORD occur approximately 85 percent of the time.

Current airside operations are limited due to runway capacity quotas imposed on ORD by the FAA. Maximum number of operations is limited to 135

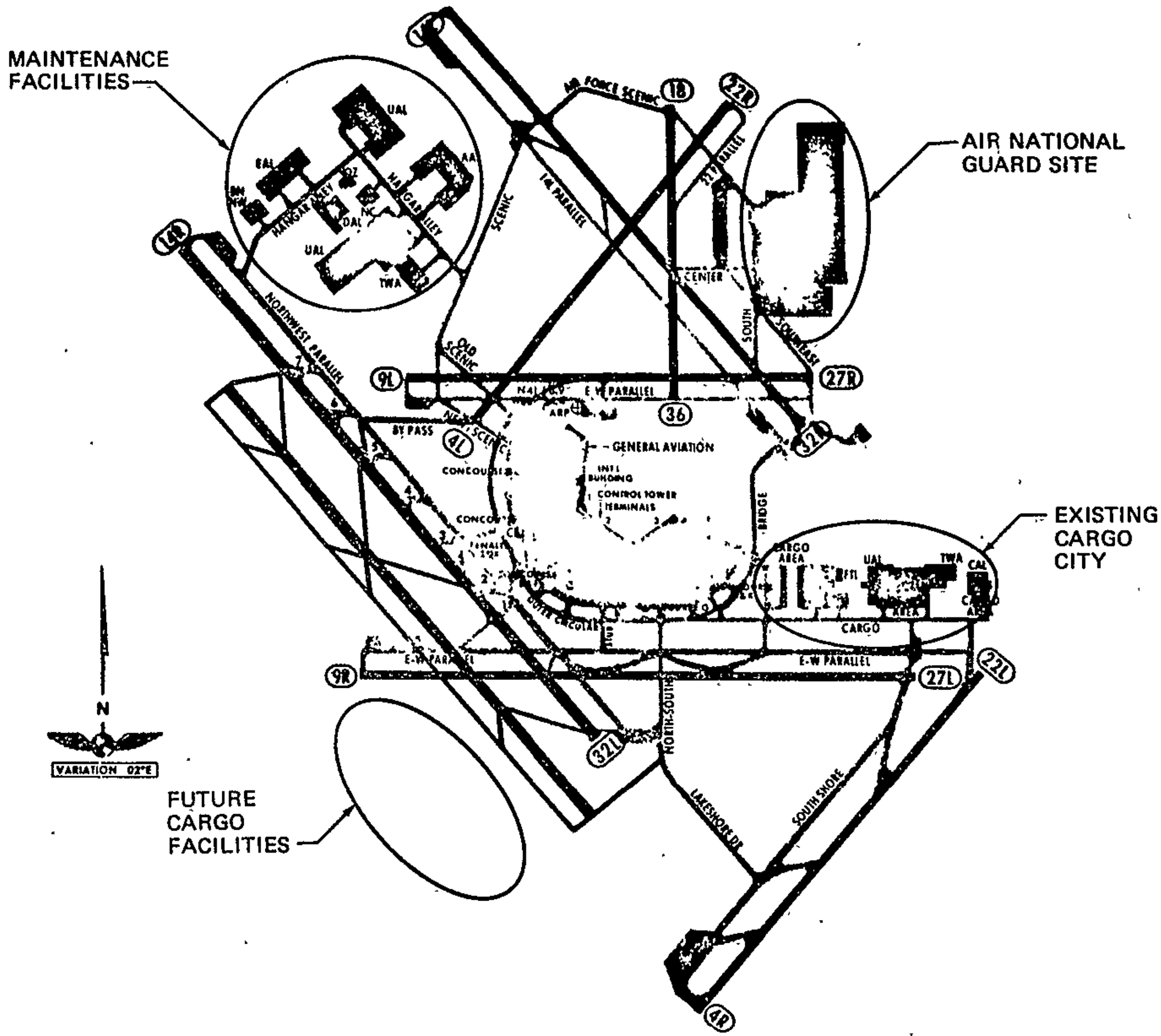

Figure 3-8. Chicago O'Hare International Airport Layout

operations during the daylight peak period. The normal peak period is between 0700 and 2000 hours. With FAA approval, the quota can be increased to 160 hourly operations. Chicago O'Hare is the busiest airport in the world and has no distinct peak hour as such. The time span between 0700 and 2000 has an even demand profile of approximately 135 operations per hour. As such, ORD has reached airside saturation. This can impact the operations of international cargo movement with 63 international passenger and 25 freighter flights during this period. Domestic airfreight moves at night with 80 percent of the all-freighter aircraft operations at ORD between 2300 and 0500 hours. The 23 percent of freighter flights operating during the quota period are frozen. It will be necessary to accommodate the 8-percent growth in cargo during this period either by higher belly-pit utilization and/or larger passenger and freighter aircraft.

Additional runway capacity can be achieved if the area south-southwest of runway 14R/32L is utilized for another runway. This area is large enough only for a VFR runway parallel to 14R/32L since independent runways must be separated with a minimum 1524 meters where the threshold of the two runways are on the same alignment.

The added lift capability also has its drawbacks. For one, the runway would use up the area that has been designated as the future site for the new Cargo City complex. Expansion of cargo facilities would have to take place offsite. The new runway would also create an imbalance of capacity requirements of the other elements on the airport. Additional gates would be required to handle the anticipated ramp area traffic. Additional access capability will have to be achieved to handle the added airport-related traffic. Both these items are current constraints at ORD.

There are approximately 70 gates at ORD. To achieve more gates, the airport authority mentioned the possibility of acquiring the land now held by the Air National Guard on the north side of the airport. This area would be used for the new international passenger terminal complex. The current international gates in the B terminal complex could be used for domestic service.

Split terminal operations would create quite a passenger, baggage, and freight problem since approximately 52 percent of the passengers at ORD make an interline or an online transfer. Additional transportation facilities on the ground must be created to handle the movements between the two terminal complexes. Also, since the National Guard site is approximately 2.5 kilometers from the main complex, longer connect times must be instituted to ensure proper transfer of passengers and freight. The greater distance from the current and future Cargo City areas to the National Guard site will call for longer transportation times for international cargo for belly-pit and combination aircraft. Thus, longer cargo cut-off times must be required by the airlines to achieve sufficient time to build unit loads, transport the unit loads to the aircraft, and loading them.

The ORD Cargo City is located 2.75 kilometers to the east of the passenger terminal complex. Major maintenance facilities are located 2.20 kilometers to the northwest of the passenger terminals. The area surrounding the airport complex is primarily industrial and green belt with the railroad marshalling area on the south side and the residential area of Des Plaines on the north side. Access to the passenger terminals is from Interstate 94, Tri-State Tollway and Mannheim Road. Access to Cargo City is also from Mannheim Road south of the airport main entrance. This does not create congestion since cargo-related truck traffic is segregated from the airport passenger-related traffic.

The landside ground access problem is currently approaching saturation because of the placement of cloverleafs and interchanges on the expressways which feed ORD. They tend to mix trucks and cars for both airport and non-airport traffic. Traffic which tends to go north-south must pass the entrance to ORD. A new highway has been constructed west of the airport which should alleviate some of the crosstown traffic. It was mentioned by the airport authority that it is not uncommon to see a 12.2-meter trailer rig which took a wrong turn on the expressway in front of the passenger terminals. Consideration has also been given to extending the Chicago Transit Authority to ORD, but it is doubtful if this would relieve much of the traffic congestion. Passenger movements are to and from dispersed areas.

The truck traffic volumes generated by the activities of Cargo City are a problem, both currently and in the future. The airport authority indicated that during the night peak freight hours, the main access road in Cargo City is congested with freight forwarder traffic, employee traffic, and airline cargo cart and cart train traffic. The problem stems from having only two lanes for traffic, lack of access control, no left-turn lanes and a speed limit of 24 kilometers per hour on the access road. The internal service road leading to the passenger terminal from the Cargo City is congested with cargo and baggage equipment and airline ground support equipment. Several years ago, without containerization and wide-body aircraft, the roadway was saturated with traffic. During the peak period from 1530 to 2000 hours, the average speed was about 8.05 kilometers per hour during good weather, dropping down to 1.61 kilometers per hour in bad winter weather. The current constraint is that the service road must cross some active taxiways. This slows down the traffic flow since the aircraft on the taxiways have ground movement priority. The airport authority has widened the service road to 9.15 meters total right of way for both lanes of traffic. This is sufficient for vehicles to pass the slower moving dolly trains. Also, the posted speed limit is 32.19 kilometers per hour for increased road capacity.

The existing cargo terminal and ramp facilities are basically exceeding saturation. During an interview conducted with the airport authority 3 years ago, it was indicated that an additional 16 258 square meters of terminal facility space were required at that time. In 1974, the cargo facilities were congested. During the interview and terminal survey portion of this study, this point was again substantiated. Many airlines are using the existing terminal space as a warehouse function for inbound, outbound, and transfer freight. The buildup, breakdown, and storage/staging functions are accomplished outside on the aircraft ramp area.

Cargo City ramp facilities were originally designed to provide adequate parking areas for DC-6/DC-7 type propeller-driven aircraft. The current ramp facilities restrict B747 freighter operation. United Airlines has the largest ramp area in Cargo City and could handle four to six B747 freighters simultaneously. Since the ramp at the Pan American terminal is limited, their B747 freighter is serviced on the United ramp. This necessitates moving cargo and handling equppment about 0.8 km over the service road.

The Continental Airlines ramp has sufficient room to handle two B747 aircraft, but due to the high tail height of the aircraft, it would present an obstruction because of the penetration into the clear zone approach plane of runway 22L. Therefore, the B747 is restricted from operation on this ramp. Other freighter aircraft such as the B707 and the B727CF can operate on the ramp, but must be towed in and out of the main cargo city taxiway. Discussions with airline representatives indicated only 9 to 11 potential gates in Cargo City which can handle a B747 freighter. These gates are allocated as follows:

American Airlines	1
Flying Tiger Line	2
TWA	1
United Airlines	4 - 6
Northwest Orient	1

In light of the severe cargo facilities constraints, the airport authority designated land south southwest of runways 9R/17L and 14R/32L for a new Cargo City about 5 to 10 years ago. This area could serve the passenger terminal complex by a tunnel and 1.4 km service road. The present Cargo City facilities would be considered for freight forwarder use upon completion of the new area. No action has been taken because it is thought that the high cost of developing the area is too prohibitive. The new Cargo City is approximately 8 years from being a reality. The new Cargo City would also eliminate some access congestion since it would interface with Irving Park Road on the opposite side of the airport from the passenger terminals. There may even be potential for distribution of cargo by railroad spur due to the proximity to a major marshalling yard, although this concept may be in the distant future.

The airport authority realizes that it has a noise problem, but tries to minimize it by operating in all directions of the compass. At night, the airport minimizes the noise exposure by operating over the east, west and south areas which are not highly sensitive to noise. The airport authority had initiated community education programs in the surrounding areas, but these programs had the reverse effect relative to its goals; more people complained about aircraft noise after the program started. These educational programs were stopped. Currently there are no curfews which limit night operations, but the Illinois Attorney General's office is initiating action relative to a total shutdown of ORD operations from 2200 to 0700 hours. This is an attempt to impose noise limitations at the airport. Since nearly 80 percent of the freighter operations occur during this time slot, an action like this would be disastrous to air cargo. The belly-pit operators will also be affected by a potential curfew in the quoted hours. As an example, Continental Airlines has six flights (five are wide-body aircraft) operating in the noted time period.

ORD plans to meet the 1990 flow objectives by primarily planning and constructing a most badly needed new Cargo City complex on the south southwest portion of the airport. Being approximately 8 years away, this new complex will fill a big void in cargo terminal warehousing and ramp facilities. In moving the terminal facilities away from the passenger terminal area, some of the cargo-related traffic will be removed from the main access roads, namely Mannheim Road, Interstate 94, and the Tri-State Tollway. This will extend the life of the existing facilities by reducing the current volume-capacity ratio. Also, with the new facilities closer to the passenger terminal area by 36 percent, freight movement will be faster due to the shorter distance that it must traverse. In addition, much of the internal service road congestion will be eliminated because access to the passenger terminal facilities will be under the runways via a tunnel. Currently, the surface traffic must cross active taxiways which cause much stoppage of vehicle movement due to aircraft movement priority.

Detroit Metropolitan Wayne County Airport: - The current configuration of DTW is presented on Figure 3-9. The two parallel runways (3/21) are used approximately 93 percent of the time. The separation distance is less than

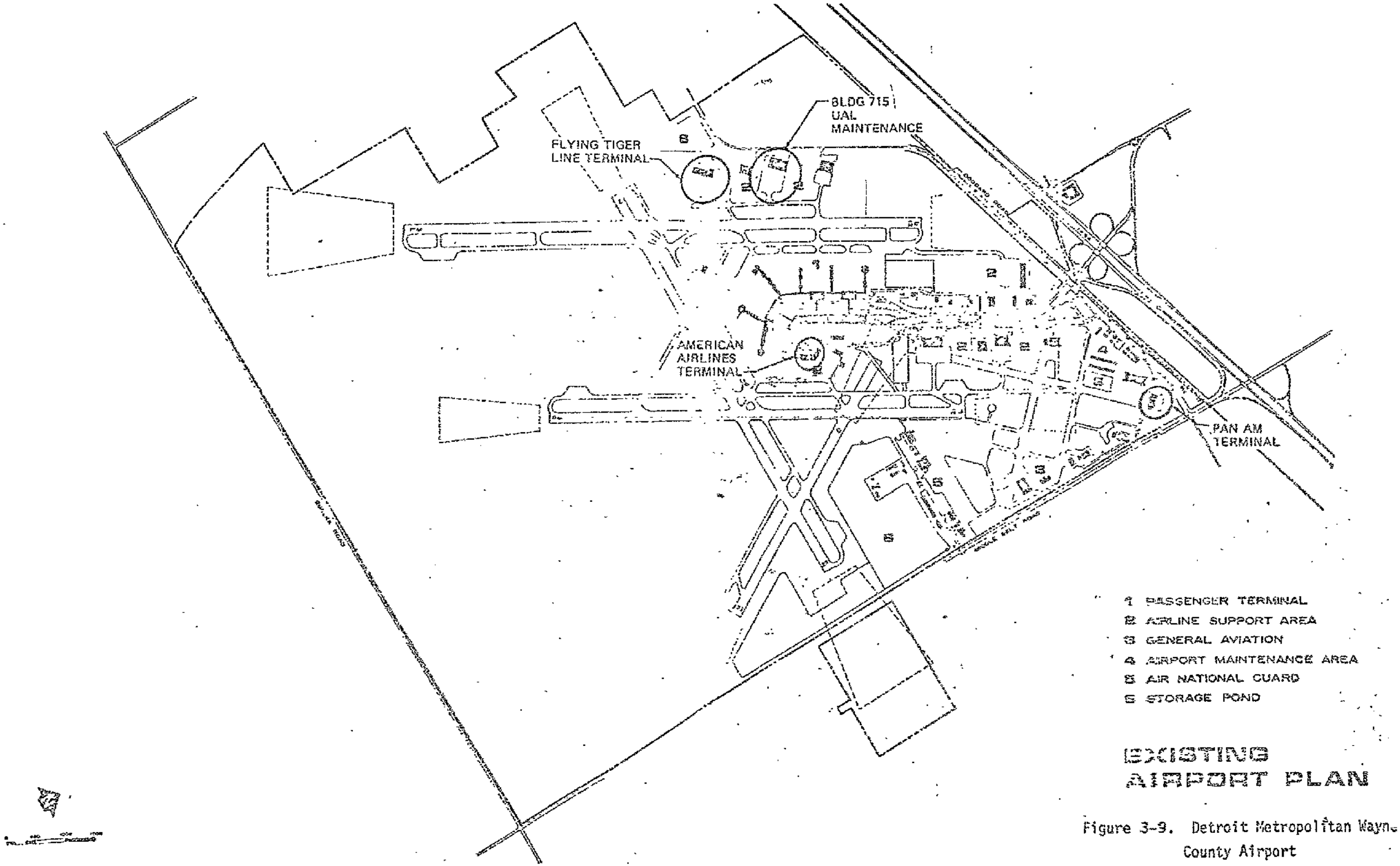

Figure 3-9. Detroit Metropolitan Wayne County Airport

1524 meters, thus the runways cannot be used independently under IFR conditions. This constraint has recently been rectified with the addition of another runway parallel to the existing pair of runways. This addition is to the right of runway 3R/21L and is separated sufficiently from the 3L/21R runway such that independent operations on the two extreme runways are feasible during IFR conditions.

The crosswind runway 9/27 is utilized the other 7 percent of the time. The airport authority indicated that another crosswind runway will be constructed in the near future plus extending runway 3L by 610 meters. These programs are currently in the EIR stage with addenda being filed relative to noise and capacity. Also, the future calls for a third parallel crosswind runway to be constructed sometime in the 1990 time frame. With two sets of three parallel runways, DTW will ultimately have a runway capacity of 556 000 movements annually. This is more than adequate for the 380 000 movements that are projected for the 1990 time frame.

The locations of the passenger and cargo terminals are also presented on Figure 3-9. The domestic passenger terminal is located between the two parallel runways and north of the crosswind runway 9/27. The domestic terminal is oblong in configuration and primarily faces the east side of runway 3L/21R and the north side of 9/27. Recently, an international terminal separate from the domestic terminal was constructed and is located to the east of the end of runway 21R. The terminal complex is served by three access routes which lead into the airport. The main entrance, Merriman Road, handles about 95 percent of the airport-generated traffic while Middle Belt and Wayne Roads handle the remaining 5 percent.

From Figure 3-9, the location of the cargo terminals are widely dispersed with the Flying Tiger terminal located at one extreme on the west end of the airport and the Pan American terminal at the east end of the airport. With these facilities being so spread apart, circulation of vehicular traffic within the airport is intermixed with truck traffic serving the cargo terminals. The cargo terminal facilities were developed by individual airlines at Detroit.

Most have built next to their maintenance facilities because they have the ramp area for potential all-freighter operations. The airlines which have pure cargo terminals at Detroit are American, United, and the Flying Tiger Line. Flying Tiger Line has the largest terminal and probably the only one with excess capacity. The distance between the passenger terminal to the Flying Tiger facility is approximately 1 kilometer. To the Pan American terminal at the other end of the airport, the distance is about 2.25 kilometers.

The area surrounding the airport consists primarily of green belt areas. This provides a good buffer area for the noise aspects of aircraft operations. Much of this area is under airport jurisdiction because the airport authority had the foresight to acquire the land for expansion purposes. To achieve the ultimate airport growth, as outlined in their airport master plan, for the 1990 time frame, the airport authority has about 98 to 99 percent of the land under acquisition.

Cargo facilities at DTW appear to be adequate. The facilities that were surveyed were operating at approximately 50 percent of capacity. Additional capacity could be achieved by expansion of the physical plants or by the addition of more mechanized processing systems.

One problem that DTW is encountering is the environmental issue. As an example, the airport authority had difficulty filing an addendum to the basic EIR for the construction of runway 3R/21L (for noise and capacity). The construction was held up for 1 year. With the delay, it also held up the contractor for that period of time; thus $3.5 million in claims were paid by the airport authority.

The future airside additions of constructing another crosswind runway and extending runway 3L by 610 meters will also involve environmental problems. The airport authority is in the process of filing the addendum to the environmental impact report relative to the issues of noise and capacity. Per the airport authority, the extension of the existing runway will not be too bad environmentally, although they will get a lot of complaints. The second east-west crosswind runway will be a major problem.

The only wide-body freighter airplane operating out of DTW is the Pan Am B747. Due to pavement strength restrictions on the Pan Am ramp, the unloading and loading of the airplane are accomplished at the United Airlines maintenance hangar, Building 715, on the northeast side of the airport. The unit load buildup and breakdown occurs at the Pan Am terminal, and loads are transported to and from the UAL ramp via 13.4-meter-long flat-bed trucks. This process is similar to the American and Flying Tiger B747 servicing at LAX.

Ground access is a current problem at DTW, but per the airport authority it is a problem they can cope with. There are three access routes into DTW; Merriman Road (the main entrance), Middle Belt, and Wayne Roads. Approximately 95 percent of the passenger-related traffic uses Merriman Road. Many of the cargo terminals are located off the main internal road system; thus traffic capacity on the roads is reduced due to the influx of cargo-related truck traffic. Basically, the cargo-related truck traffic will use the Wayne and Middle Belt Road entrances.

In terms of providing improvement to the ground-access problem, a near-term modification would be the redesign of the on- and off-ramps on Middle Belt Road and I-94 to provide full-access control. This would increase the throughput capacity for both I-94 and for Middle Belt Road.

Aircraft noise has been a problem at DTW but does not have the severity as some of the other airports. The airport authority indicated that the FAA was the major constraint in terms of their noise policies. It was indicated that the FAA should be able to do a better job.

Air cargo constraint trends. - Due to the differences in the nature of the air cargo and the operational facilities at each of the five airports that were surveyed, it is very difficult to generalize on a set of conclusions that would characterize all the airports in terms of constraints. But from the individual airport summaries of each of the airports in the previous sections, the following similarities and trends in airport and air cargo constraints were determined:

- Environment -
  - Noise
  - Surface congestion
  - New construction
- Capacity -
  - Runway saturation
  - Aircraft size
  - Efficient facilities

Environment-noise: The primary issue which all the airports have in common is that of noise. The current focus is in New York at J.F. Kennedy International Airport which involves the landing rights of the Concorde SST. The latest political decision is to let the SST operate into JFK much to the chagrin of the environmentalists who have opposed this action because of the high noise levels generated by this aircraft. Other airports that are currently encountering noise issues are ORD and LAX although ATL and DTW have problems, but to a lesser degree. The problems at ORD stem from the operation of aircraft over the residential area of Des Plaines to the north of the airport complex. Also, the current impedance of the State Attorney General's office which is trying to introduce legislation calling for a curfew at ORD between the hours of 2200 and 0700 because of the impact of high noise levels on the surrounding areas. At LAX, the current movement is directed at the additional noise generated by freight truck traffic around the airport proper. With more usage from CLC unit load devices, the argument used by the environmentalists that an increase in air cargo will directly increase truck traffic does not seem well founded. Because of CLC devices, a reduced level of truck traffic can result from an increased level in air cargo volume.

In summary, the problem of noise is and has been felt by all the airports that were surveyed. From the comments received from the various airport authorities, the problem of noise is expected to grow in intensity through the study time frame to 1990. The airframe manufacturers and the federal regulatory agencies are working from the technical point of view in developing quieter, more efficient equipment to meet the noise certification levels that have been imposed for future aircraft. From this point of view, noise-impacted areas around the airport, in the future, will be reduced due to the low noise characteristics of these new aircraft.

Environment-surface congestion: The five survey airports are currently encountering landside access congestion problems due to the lack of adequate facilities that are required to handle both the airport- and nonairport-related traffic. This constraint is very serious in that it hinders the growth of both commercial passengers and freight since both, in general, use the same rights of way. The problem is very acute at LAX because (1) the current volume of airport traffic at 28 million per year is approaching the 30 million service capacity of the access route and (2) Century Blvd. is the main access route for freight-related traffic which serves the main Cargo City area. LAX is currently studying the problem through a traffic engineering consultant. The final results should be forthcoming shortly.

The Van Wyck Expressway at JFK is handling the majority of the passenger-related traffic plus 10 percent of the truck-related freight traffic. The airport authority is adding another access route into JFK off Rockaway Boulevard towards the east end of the airport. This route will divert the freight traffic from the Van Wyck Expressway, thus reducing the volume of traffic on it and extending its lifespan before it reaches saturation.

The situation at ORD is in the design and location of the expressway intersections and cloverleafs on the routes which lead into the passenger terminal areas. The directional flow is such that a majority of the north-south crosstown traffic is funneled past the entrance to ORD. A new roadway to the west of ORD will divert some of the crosstown traffic and relieve the constraint to some extent. When the cargo city complex is moved to the south-southwest side of the airport, a majority of the air cargo-related traffic will be diverted from the vicinity of the main access route. The complexity of the geometric design of the landside road system also contributes to some of the delays and congestion. As previously reported by the airport authority, it is a common sight to see a 12.2-meter trailer rig in front of the passenger terminal after having made the wrong turn on the expressway.

DTW currently has a problem with ground access, but it is a situation which is controllable. The airport authority recognizes this problem and has begun preliminary planning on several landside projects which will enchance the flow characteristics and system capacities in the near future.

The new midfield terminal concept at Atlanta was conceived to relieve both airside and landside constraints on the current airport structure. The current landside ground access capacity is saturated during peak operations. With the midfield concept, the new airport access will be located off Interstate 85 which will have greater capacity to handle the current demand plus the demand in the 1990 time frame.

In summary, landside ground access capacity is an important link in the overall airport system. To provide for a sufficient commodity flow level between the airport and its surrounding environs, an adequate balance of capacities between the airside and the landside must be maintained. In essence, the five survey airports are encountering ground access problems. Lack of sufficient capacity will stifle the growth of passenger traffic as well as air cargo. The airports have recognized this problem and are providing additional capacity either through additional facilities or the redesign of existing facilities.

Environment-new construction: Due to various environmental issues, new construction programs at the survey airports have encountered varying degrees of delays in the commencement of construction. At the one extreme, the Sepulveda tunnel strengthening program at LAX has been delayed for more than 8 years. The airport authority indicated that in 1969 the plans for redesign to support the heavier wide-body aircraft were in existence. Due to the pressure exerted by environmentalists and politicians who are against the program, the construction has been delayed to the present. Hopefully, the tunnel will be modified in the early 1980 time frame.

The environmental issues also surfaced at JFK several years ago when the airport authority wished to extend runway 4L into Jamaica Bay. On their own volition, they commissioned a private study to determine the impact of the new construction on the environment in the surrounding areas. The finding of this study indicated that the extension of runway 4L would be detrimental to the environment; thus, all thoughts of additional runway length programs at JFK have ceased. In terms of on-airport facilities, the airport authority has had very little difficulty with the environmental issue.

At DTW, the construction of their new third main runway has just been completed with operations to commence in the near future. This program encountered a year and a half delay in construction due to environmental issues and environmentalists. Also, $3-1/2 million in claims were paid by the airport authority for the delays. Future programs at DTW are expected to encounter greater opposition due to these issues.

ATL and ORD have not encountered very much opposition from environmentalists. The new midfield terminal complex is under construction seemingly without too much outside pressure. But in the future, ATL will face considerable opposition if a new airport must be constructed to relieve the Hartsfield complex in the 1990 time frame and beyond.

In summary, the current environmental atmosphere is in opposing most forms of airport improvement. This trend as viewed by the airport authorities will become excessively stronger in the years to come.

Capacity-runway saturation: Of the study airports, LAX and DTW have sufficient runway capacity to handle the anticipated aircraft operational demand through the 1990s. JFK and ORD have quotas which limit the number of aircraft operations during some of the peak hours of the day. ATL is currently encountering heavy runway delays because of airline scheduling practices and less than optimum runway configuration in which aircraft operating from the southern pair of parallel runways must cross an active taxiway in getting to and from the passenger terminal. The new midfield configuration will eliminate the runway geometry problem, but the scheduling practices must be solved by the airlines.

Much of the problem at ATL occurs during the morning and afternoon peak periods. Being a belly-pit-oriented air cargo airport, the delay constraints and the lack of adequate runway capacity is detrimental to the air cargo industry since freight is carried on these prime time operations. All-freighter aircraft currently operating into ATL are basically night oriented and consequently are not affected by these airside inadequacies.

At JFK and ORD, the growth of air cargo during the quota hours is confined at present to the aircraft that are operating in these hours. Additional growth can be achieved if the smaller jet aircraft are replaced by larger aircraft with more available cargo volumes or by all-freighter aircraft. Due to the nature of airfreight which inherently moves at night, freighter aircraft operations can increase during these off-peak passenger hours almost at an unconstrained rate. Once saturation is reached at these airports, other alternatives that are available to achieve growth are to develop additional hubs and hub airports and/or to distribute the aircraft to other major hubs in the area.

Capacity-aircraft size: The size of current all-freighter aircraft was found to be a constraint only in conjunction with some other airport airside constraint. As an example, the Sepulveda tunnel strength characteristics prohibits wide-body aircraft from entering the cargo city area at LAX. Therefore, the B747F aircraft are serviced at the respective aircraft maintenance facilities at the opposite end of the airport. This type of split operation calls for additional manpower and for longer cutoff times because of the transportation time required to go from the terminal to the aircraft. Another problem at LAX is the existing ramp areas in Cargo City. Since they were designed for narrow-body all-freighters like the B707 and the DC-8, they are less than optimum for the B747F even if the tunnel structure was of sufficient strength to allow movement of a B747F into that area.

Insufficient ramp size is also a constraint at ORD since that facility (Cargo City) was initially designed for DC-6/DC-7 aircraft. Some airlines can handle wide-body aircraft but at less than optimum operation. United Airlines has the largest ramp area at ORD and a cursory review of the area indicates that approximately four to six B747F aircraft can be serviced simultaneously. Pan American currently uses the UAL facility which is 0.8 kilometers from their terminal facility. Other airlines which have the capability to handle the B747F are American Airlines, the Flying Tiger Line, TWA, and Northwest Orient.

ATL currently has no wide-body freighter aircraft operating into the Cargo City area. But the facilities were designed for wide-body aircraft with the ramp capable of handling 12 B747F simultaneously parked in a nose-in tow-out mode.

At DTW, the Pan American B747F is the only wide-body all-freighter aircraft operating into that airport. Because of insufficient pavement strength at the Pan Am terminal ramp, the B747 must be parked on the other side of the airport at the UAL maintenance facility. Servicing of the aircraft is similar to the LAX operation with the unit loads transported on flat-bed rigs to and from the terminal.

At JFK, the airport authority indicated that no problems exist on the airside relative to handling wide-body freighters at the cargo terminal. The only constraint that was observed was the limitation of the number of aircraft that could be handled due to physical size of the ramps.

Capacity-efficient facilities: In conducting the various cargo terminal surveys, it was observed that the terminal and ramp facilities ran the gamut from the very labor-intensive bulk-handled system to a very mechanized system concept with elevating transfer vehicles handling the flow in the terminal and fixed-dock aircraft-loading facilities on the ramp. Additional capacity in the terminals, in the near term, can be enhanced by increasing the efficiency of their operations through some form of mechanization. But since the makeup at each terminal was somewhat different from the others, even within a given airline, each terminal will benefit to varying degrees with mechanization. Many airlines do a substantial international business which requires longer warehousing time, thus reducing some of the benefits of mechanization. Also, some of the smaller carriers cannot be expected to develop the same efficiencies as the larger carriers because of financial constraints.

One of the major constraints to obtaining more efficient facilities is the limited availability of money. From the terminal surveys, most of the terminals had room to expand in both horizontal as well as vertical directions. But there exists a lack of sufficient airline capital to develop and enhance these facilities.

Surveyed Airports Growth Potential. - The variances in the degree of current cargo terminal utilization at the five candidate airports ranged from total saturation at Chicago O'Hare International Airport (ORD) to approximately 50 percent of total terminal capacity at Detroit Metropolitan Wayne County Airport (DTW). With this wide range of variation, the future requirements for additional cargo terminal facilities at these airports are a function of how quickly the remaining capacity is utilized to satisfy the anticipated 1990 flow levels. The projection of future requirements is very difficult to assess because of both tangible and intangible constraints at the various sites. These can range from physical to political — from lack of capital to construct new facilities to strong antiairport environmentalists who attempt to suppress airport expansion. The five airports surveyed in Phase I of the study each have a different make-up of the previously mentioned parameters; thus, each airport will be discussed separately.

Los Angeles International Airport (LAX): The current cargo facilities at LAX are separated into two main sites. The major cargo city complex is located in the northeast sector of the airport bounded by Century and Aviation Boulevards. The second location is situated on the southern boundary of the airport along Imperial Highway and contains several cargo terminal buildings as well as some industrial sites. Basically, the cargo city complex handles the majority of the airport cargo throughput with 82.5 percent of the flow handled in this area. The Imperial Highway complex handles 14.9 percent of the flow with the remaining 2.6 percent processed from off-airport terminals.

The flow of air cargo through LAX has grown at an average annual rate of 10 percent over the last 10 years. A summary of the 1976 throughput at LAX is documented earlier in this section. The total volume of freight handled at LAX in 1976 was 699.3 million kilograms. Based on current econometric projections, air cargo is expected to expand two- to threefold over the 1976 baseline figure by the 1990 time frame to over 2200 million kilograms.

In 1968, an engineering consulting company determined that the ultimate gross capacity of the LAX facilities is 12.02 million kilograms per gross acre per year. The current cargo city acreage is 81 acres. By deleting the post office and associated roadways, the total net area available for cargo operations is 71.26 acres. Using the capacity given above, the ultimate capacity of cargo city is 857.3 million kilograms per year. Adding the volume that is handled on the south side, the airport freight facilities should be saturated sometime after 1980.

The LAX airport master plan identifies immediate as well as long-term solutions to handle the projected demand for air cargo. The immediate solutions are to:

- Reinforce the Sepulveda tunnel to handle higher gross weight and wide-body aircraft.
- Extend Air Freight Building 1 four to five bays (see Figure 3-3).
- Construct a new airfreight facility west of existing Air Freight Building 1.
- Encourage cargo city tenants to further increase warehouse capacities through mechanization and with the use of cargo ULD by-pass systems.
- Extend the Flying Tigers Line, American, and TWA facilities.

Additional facilities must be built to accommodate the flow indicated by long-range forecasts. Three areas are being considered for future development — the south, west and north sides of the airport. The most logical site for initial development is the south side of the airport between Sepulveda and Aviation Boulevards (see Figure 3-5). The west side, along Pershing Drive, and the north side show great promise because they are presently undeveloped. However, both these latter areas require substantial capital to develop and face zoning problems that may take considerable time to resolve. The master plan of the south side calls for 77 690 square meters of warehouse space allocated to three buildings. One of these buildings will be oriented to the runway with a frontage area sufficient for 11 B747 aircraft parked parallel to the building. The remaining two buildings will have, in total, 10 B747 parking positions and one DC-8 position.

Compatibility of the south side future facilities may be constrained due to the lack of sufficient area between the runway complex and Imperial Highway. The distance from the runway centerline and the edge of the right of way is approximately 396 meters at the current Air Freight Building 4 (the alignment of the southern runways and Imperial are not parallel). To achieve a balance for truck dock and maneuvering space and for employee parking along Imperial, the south facilities are designed with the existing B747 freighter as the critical airplane. With the B747 parked parallel to the longest building, the tip of the B747 vertical stabilizer touches the imaginary 7:1 slope from the instrumented runway at a distance of 290 meters from the centerline of the runway. Allowing for aircraft-to-building clearance, the necessary building setback would be 335 meters from the centerline of the runway. With B747 power-in and tow-out parking, aircraft nose in, the building setback line would be an extra 37 meters to conform with the 7:1 slope and would eliminate over 11 acres of potential warehouse and processing space. According to the LAX master plan, the difference between the two modes of aircraft parking is only one position in favor of the power-in and tow-out mode over a terminal length of 869 meters.

Since the facility is designed for the existing B747 dimensions, any derivative aircraft with increased length will not be compatible with the facilities because the spacing will be fuselage-length critical instead of wing-span sensitive for nose-in parking. The DC-10 stretch aircraft fits the dimensional envelope of the B747 and will be compatible with the facilities. The stretch B747 will not be compatible due to the longer fuselage and, hence, will result in the loss of valuable gate space.

J. F. Kennedy International Airport (JFK): The current cargo facilities at JFK are located approximately 2 kilometers from the main passenger terminal complex along the north and west sides of the airport. As shown in Figure 3-6 the terminals located on the west side of the airport are located adjacent to the Van Wyck Expressway which is the main access/egress thoroughfare serving the airport. The northern cargo terminals are located along the North Boundary Road without direct access to off-airport roads.

Relative to future air cargo terminals, the Port Authority indicated that a master plan for additional cargo facilities has not been developed only because additional facilities are not required in the near future. Additional capacity can be achieved through either expansion of existing terminal floor plans and ramp areas or through varying degrees of mechanization. Added capacity can also be achieved by using hangars and other airport on-site buildings when they become available. At the time of the CLASS Airport Survey, the Port Authority indicated that TWA was the only airline looking towards near-term expansion. They are viewing the old United States Post Office site on the north side of the airport as potential ramp space area for their all-freighter aircraft.

The main constraint to expansion at JFK is the lack of airline capital. There are no physical constraints in terms of vacant land since there is a large tract of undeveloped land to the east of runway 412/22L. This area would be an ideal location for a pure all-freighter operator since it is away from the major hub areas of the airport. The airport authority also indicated an area around the perimeter of the airport which would provide ideal locations for future off-airport terminals. In addition, the city is currently planning, or proposing, an industrial park to be located just north of Rockaway Boulevard. This area would provide an excellent location for off-airport terminals if it were not for the fact that it may present a problem for future airside expansion. If runway 22L is extended, as presently being considered, then buildings constructed in this industrial park could present obstructions to operating aircraft.

The requirement for adequate cargo facilities is paramount to any airport for it ensures a smooth transitional flow of air cargo from airside to landside and visa versa. This is more pronounced at JFK since it is the major origin-destination center on the east coast of the United States and is the major hub for international traffic. In 1976, the total throughput flow at JFK amounted to 1089 million kilograms with domestic volume accounting for approximately 38 percent and international traffic 62 percent of the total flow. The cargo volume at JFK ranked this airport first in the nation with a volume that was 45 percent greater than the second-ranking airport (ORD).

The forecast of future air cargo volume was obtained from the Aviation Economics Division of the Port Authority and shows two rates of growth between now and 1990. From 1976 to 1980, the total domestic and international volume is expected to increase at an annual rate of 5.92 percent from 1089 to 1588 million kilograms. From 1980 to 1990, the annual growth rate is expected to increase to 9.9 percent with the flow increasing to over 2800 million kilograms. If these growth rates are realized, then the five cargo terminals surveyed at JFK, apparently operating at about 80 percent capacity, will become saturated in the early 1980s.

Atlanta William Hartsfield International Airport (ATL): Cargo is currently processed in two areas at ATL. As indicated on Figure 3-7, a small facility operated by Eastern Airlines exists opposite their passenger terminal with the larger cargo-handling facility located east of the passenger terminal area. This orientation is convenient since it reduces the time and distance associated with transporting belly-pit freight to the passenger terminal. The major tenants in the north facility are Delta and Airlift International who rank one and two, respectively, in throughput tonnage at ATL.

The north cargo complex ramp area is sufficiently large enough to handle 12 wide-body freighter aircraft. The frontal area along the ramp is approximately 823 meters, thus providing adequate wing-tip clearance of 12 B747 aircraft parked in nose-in-mode. At the present time, the north complex is only two-thirds occupied with freight forwarders and airline tenants, and the only freighter aircraft using this complex are the DC-8s of Airlift International. Based on airline data received from the ATL airport authority, approximately 79 percent of the total throughput is handled at the north complex with the remaining 21 percent handled by Eastern at their facility.

In addition to the north cargo complex, an installation called the "central cargo area" (southeast corner of the airport, see Figure 3-7) will become operational in the 1981 time frame. The construction of this facility is in conjunction with the new midfield passenger terminal complex which will have its first phase completed by 1980. It is anticipated that the belly-pit operators will opt to move into the central complex because of its close proximity to the passenger terminal area. These moves will, in turn, make the north cargo area available for all-freighter aircraft operators whose interest in passenger operations is centered upon the problem of interline cargo transfer. Separation of facilities, in this case, will provide some handicap to the freight forwarder who prefers to have all of the cargo airlines concentrated in one area, thus reducing transportation times and equipment requirements.

The new central complex will have sufficient ramp space for 10 jumbo jet all-freighter aircraft and 20 aircraft that fall within the dimensional envelope of the current DC-8-61. The jumbo jets will have direct access to the cargo facility directly from the end of runway 27R while the smaller aircraft will reach their gate positions by means of the taxi lane between the building areas (see Figure 3-7).

Past forecasts of air cargo at ATL indicated average growth rates upwards of 9 to 10 percent; however, the most recent forecasts have revised these figures downward to reflect the slow down in the growth of the economy. Analysis associated with the CLASS surveys indicate that the 9 to 10 percent growth rates through 1990 may be the more accurate due to anticipated increases in mail volume, the possibility of international route awards to Airlift International, and the increased potential of ATL as the result of its being added to the list of gateway cities to Europe.

Chicago O'Hare International Airport (ORD): The cargo city complex at ORD consists of six cargo terminal buildings all located approximately 2.75 kilometers east of the passenger terminal complex. Access to the cargo terminal facilities is from Mannheim Road just south of the airport main entrance. Also in the cargo city complex are the freight forwarders located north of the terminal buildings. The existing cargo complex covers approximately 40 acres.

During an interview conducted with the airport authority 4 years ago, it was indicated that an additional 16 258 square meters of terminal floor space were required at that time. In essence, the overall cargo city area was, at that time, exceeding the saturation point. The recent CLASS interviews and the cargo terminal surveys have substantiated this point. Many airlines are currently using the warehouse facilities as a storage function for inbound, outbound, and transfer freight with the buildup, breakdown, and load staging functions being accomplished outside on the aircraft ramp area. In several cases, this results in there being insufficient room on the ramp for aircraft servicing. As a consequence, these operations must then be performed either on the United ramp, which is the largest in cargo city, or at the passenger terminal complex. Either makeshift solution necessitates additional manpower, equipment, and time to turn around an airplane.

The ORD freight handlers and airlines have operated under a severe handicap for several years and this condition is expected to continue for an additional 8 years. It is currently expected that during the intervening period, new cargo facilities will have been constructed at a site adjacent to runway 14R/32L (see Figure 3-8). From a ground-access point of view this site is close to major thoroughfares (Irving Park Road, as an example) and a rail link could be provided from a marshalling yard on the south side and/or by means of a spur from the west side.

In the past, the freight forwarders wanted to develop the new south side cargo facility; but, since it is in an undeveloped part of the airport, it was thought that the cost would be too prohibitive to proceed. The area has no utilities and according to the airport authority, it could cost upwards of a billion dollars to implement adequate terminal facilities adjacent to runway

14R/32L. Since this area is currently devoid of airside facilities, its development would entail the construction of such items as connecting taxiways, turnoffs, ramp facilities, service yards, etc. At the present time, there is no future master plan for the airport itself not alone for new cargo facilities. The airport authority indicated that ADAP funds will be used for this purpose once the effort is initiated.

The severity of the problem at ORD is magnified many fold when one looks at the potential throughput volume to be handled 8 years from this time in 1984. The problem is put into perspective by viewing the base year 1976 throughput volume of 751 million kilograms of cargo which ranked it number 2 in the nation behind JFK. Future forecasts given by the airport authority indicated an 8-percent growth rate for the near future. Using this rate, the total throughput at ORD will almost double to 1400 million kilograms over the 8 years until new facilities are constructed to ease the lack of terminal capacity.

Detroit Metropolitan Wayne County Airport (DTW): The locations of existing cargo terminals are illustrated in Figure 3-9. The terminals are widely dispersed with the Flying Tigers Line located at the west end of the airport and the Pan American terminal located at the east end of the airport. CLASS survey results indicate that facilities are adequate to handle the projected increased demand in the near future. A gross estimate of the current capacity utilization indicated the level to be about 50 percent with additional capacity obtainable through physical plant expansion and/or through varying degrees of mechanization. Once the existing facilities become saturated, the DTW master plan identifies two new locations for cargo processing with initial development occurring on the Wayne Road site located at the west end of the airport.

The Wayne Road site is approximately 85 acres (double the size of the current ORD cargo complex) and is totally under airport authority ownership. The facility will be developed only when there is a need for it and the financial situation is favorable. This site has the utilities and good access provided by Interstate 94 and 275, and the apron area is large enough to support 16 aircraft at one time. Facility layouts and sizes are based upon the

B747 as the critical airplane to maneuver in and out of the gate position without interferring with apron-edge taxiway traffic. Assuming that some of the existing cargo terminals will continue to be utilized, the Wayne Road location should be of sufficient size to provide expansion capability until the 1990s.

The second proposed site is located on the east side of the airport along Middle Belt Road and includes the Post Office Building for DTW. It is approximately 135 acres in size, making it the larger of the two locations, with a ramp area sized to accommodate 26 aircraft at one time. At this site, as well as the Wayne Road site, terminal area is provided for the freight forwarders.

In 1976, DTW ranked eleventh in the nation in terms of air cargo throughput with 180 million kilograms of freight. A forecast of future throughput was not given by the airport authority because of its sensitivity to the auto industry. In the master plan, the consultants estimated a growth of 15 percent annually through 1983 and a growth rate of 10 percent annually from 1983 to 1990. The airport authority thought these rates were rather optimistic.

Current Cargo Terminal Capacity and Constraints

The cargo terminal is the element in the air cargo system which controls and directs flow movements and accomplishes the interchange between air and surface transport modes. While part of the total system, separately it is a complex man-machine system operating within the environment of the airport complex and subject to many demands and constraints. The cargo terminal system must have the flexibility to handle variations in flow levels and characteristics, yet have the sophistication to accomplish its tasks with minimal cost and limited area. To establish a base for growth potential considerations, current air cargo terminal systems were observed and evaluated to assess their impact on the total air cargo system and to determine their sensitivity to varying mechanization levels, scale and type of operations, flow composition parameters, and locations.

Terminal surveys and rationale. - To assess the impact of cargo terminal operations on the total air cargo system and establish an interface with the 1990 scenario, a series of broad-based terminal surveys was conceived for the five airports under study. The five airports were considered to provide adequate breadth for location sensitivity. For variations in the type of operation, cooperation was required from airlines operating freighter aircraft only, passenger aircraft (belly-pit cargo) only, and a combination of the two. Further, variations in flow composition were desired to provide insight into the effects of transfer cargo operations, consignor-loaded container (CLC) processing, and international versus domestic cargo-handling requirements on cargo terminal systems. Based on past experience, terminal mechanization and scale of operations were also considered in establishing a list of airline candidates. Assistance in conducting the survey was requested from American, Airlift, Continental, Delta, Federal Express, Flying Tigers, Pan American, Seaboard, and United Airlines. Seven of the nine airlines pledged their assistance to the study with the understanding that individual data and inputs would be treated in a confidential manner.

Study constraints precluded an indepth analysis of each terminal. The Douglas team surveyed four terminals at LAX and DTW, five at JFK and ORD, and one in ATL. In addition, a visit was paid to Federal Express in Memphis to observe small-piece handling in their hub terminal. The visit was made primarily to gain perspective on mechanization potential; therefore, Federal Express was not included in the operator-station matrix of Table 3-3. Each terminal survey was coordinated with the terminal manager to ensure that the team would see representative processing activities. At each station, the team spent between 4 and 8 hours documenting and critiquing the processing functions on the aircraft ramp and in the cargo terminal. Interviews were also conducted for 2 to 3 hours with terminal management personnel to gain a basic understanding of their operational philosophy, objectives, and system requirements for the near and long term.

In order to conduct quantitative analyses of the cargo terminal systems, the Cargo Processing Questionnaire included in Appendix A was developed to obtain the following parameters: cargo flow, flow components and variations, time-phased processing activities, terminal and ramp areas, equipment inventory, aircraft operations, manpower levels, and cargo processing costs. The questionnaire was submitted to each airline when their assistance in the study was

TABLE 3-3

KEY - SURVEYED CARRIER

Identification No.	Operator	Terminal Location
1	A	LAX
2	A	JFK
3	A	ORD
4	A	DTW
5	B	LAX
6	B	JFK
7	B	ORD
8	B	DTW
9	B	ATL
10	C	JFK
11	C	ORD
12	C	DTW
13	D	LAX
14	D	ORD
15	D	DTW
16	E	LAX
17	E	ORD
18	F	JFK
19	D	JFK
20	A	TYO
21	A	TPE
22	A	HKG

solicited. The questionnaire was to be completed by headquarters and/or station personnel using actual data and/or their best estimates. Very few of the questionnaires were completed in time for review between the team and station management personnel during the survey. Of the 19 terminal systems which were observed, 17 questionnaires were returned with some useful information, but only five were complete. The relatively poor response to the questionnaire was generally blamed on lack of data and/or time by airline personnel. Although the incomplete data reduced the scope of some sensitivity analyses, the survey data base is more than adequate to assess current cargo terminal capacities and constraints.

Terminal processing operations. - The objective of a terminal is to facilitate the efficient movement of cargo from an origin to a destination as specified by the consignor and/or consignee. To accomplish this objective, a physical processing system must be integrated with a management and control system. While cargo is normally composed of freight, express, mail, and company material (COMAT), composition and characteristics of cargo are quite variable depending upon the time period, origin-destination, location, consignor-consignee, commodity mix, and carrier. The terminal systems may be consolidated under one roof or physically separated. Schedules for the transportation vehicles may be compatible or disparate, regular or irregular. Terminal characteristics are seldom constant since they are the results of time-phased flow levels and characteristics.

Basic functions in the cargo-processing and management and control systems are nearly always identical. Figure 3-10 illustrates the basic functions for a cargo terminal and the functional relationships between the inbound and outbound loops. Each step in the physical processing system has a corresponding step in the management and control system. For example, originating cargo is offloaded from a truck and sorted by destination while the airbills (AWB) and other documents are reviewed and then also sorted. Transfer cargo, which has been offloaded from an inbound aircraft, is also sorted by its next destination and joins the originating cargo. Both are stored by destination as outbound cargo. Similarly, inbound cargo from the aircraft is sorted and broken into its components, terminating and transfer cargo. Theoretically, the total cargo processed through a terminal is the sum of originating, terminating, and transfer flow. From a practical standpoint, most terminal records are maintained only with respect to inbound and outbound movements as developed from flight manifests. This process is justified since transfer cargo almost always requires complete double handling. Total cargo flow in this terminal study was also established as the summation of inbound and outbound flows to maintain consistency with data provided on all questionnaires.

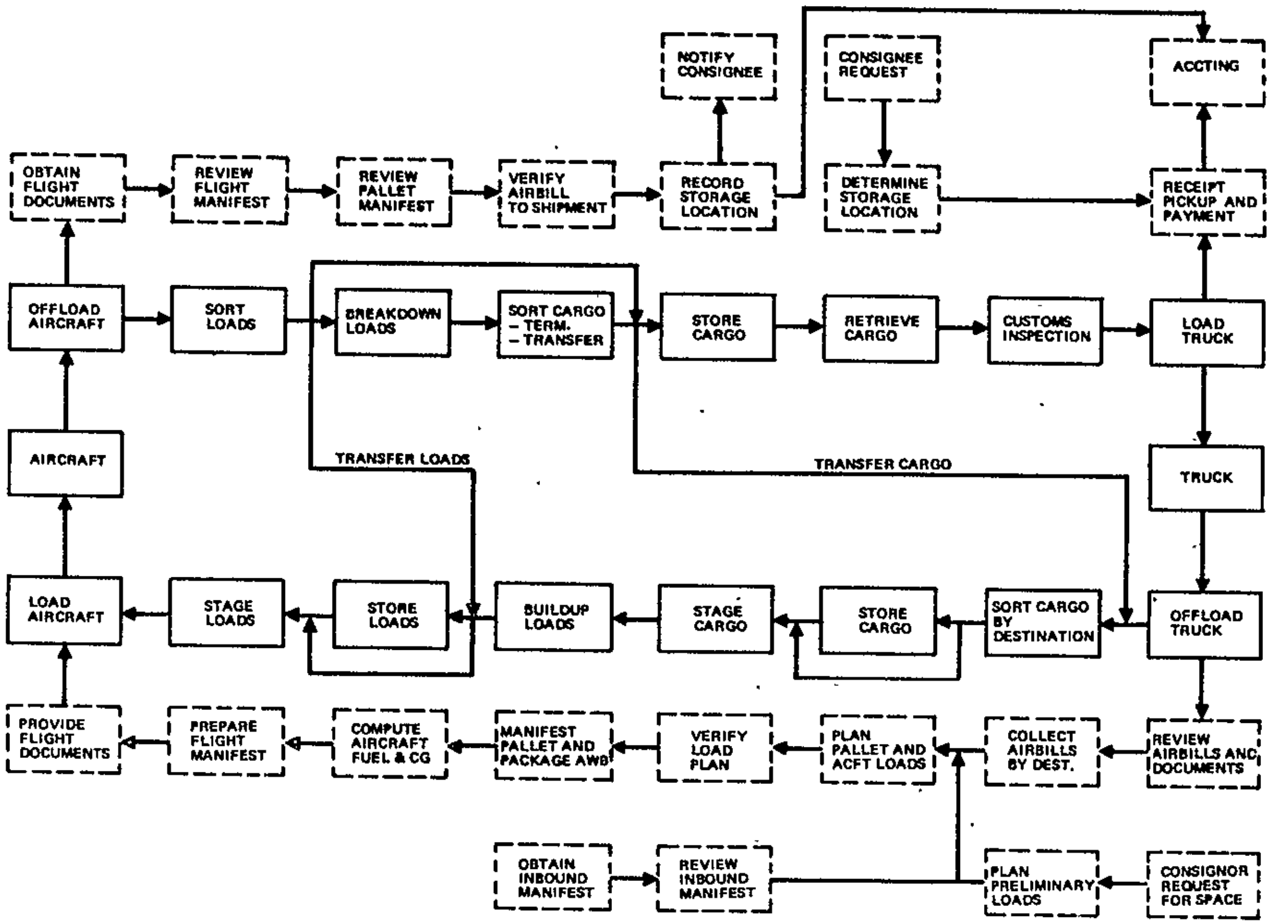

Figure 3-10. Cargo Terminal Cargo Processing and Management System Functions Top-Level Flow Model

Upon review of Figure 3-10, one will notice that the flow model is for an international terminal where customs inspection of terminating cargo is usually required. This function would simply not exist for domestic operations. The flow model is also based on a freighter aircraft with little consideration given to CLC processing or to bulk versus unitized loads. Figure 3-11 provides the next level of detail where CLC and bulk processing are defined along with bulk and unitized handling of baggage and cargo for a passenger aircraft. Even at this moderate level of detail, the complexity of airport processing systems becomes evident from a management viewpoint.

Figure 3-11 is representative of a system for a passenger aircraft (belly-pit cargo) operator. A combination operator would have freighter aircraft superimposed upon the cargo-processing network and probably require dual-ramp operations at widely separated points on the airport. Additional detailed levels of the flow model would include other options associated with special handling and storage of perishable, high-value, live, hazardous, express, over-size, mail, and priority cargo. Another series of options would include the type and size of unit load device (ULD), main-deck or lower-deck load position, cargo compatibilities, and whether the load will terminate or transfer (inter-line or intraline). A well-designed management and control system becomes as important or more important than a good cargo-processing system in light of the numerous decisions facing cargo terminal management.

Design of a new cargo terminal processing system may be accomplished approximately 5 years before the system actually goes into operation. The design must be based on a flow projection about 10 years into the future. In addition to the flow level, the system must also be based on cargo characteristics; pickup and delivery schedules for surface transport vehicles; and aircraft size, capacity, and scheduling information. A considerable number of terminals have gone into operation with design baselines that bore no resemblance to actual operating conditions. A series of modifications are then required to produce an operational entity. To minimize the investment risk and retain operational flexibility over a 10- to 20-year period, terminal processing systems and the supporting facilities should be designed and built to

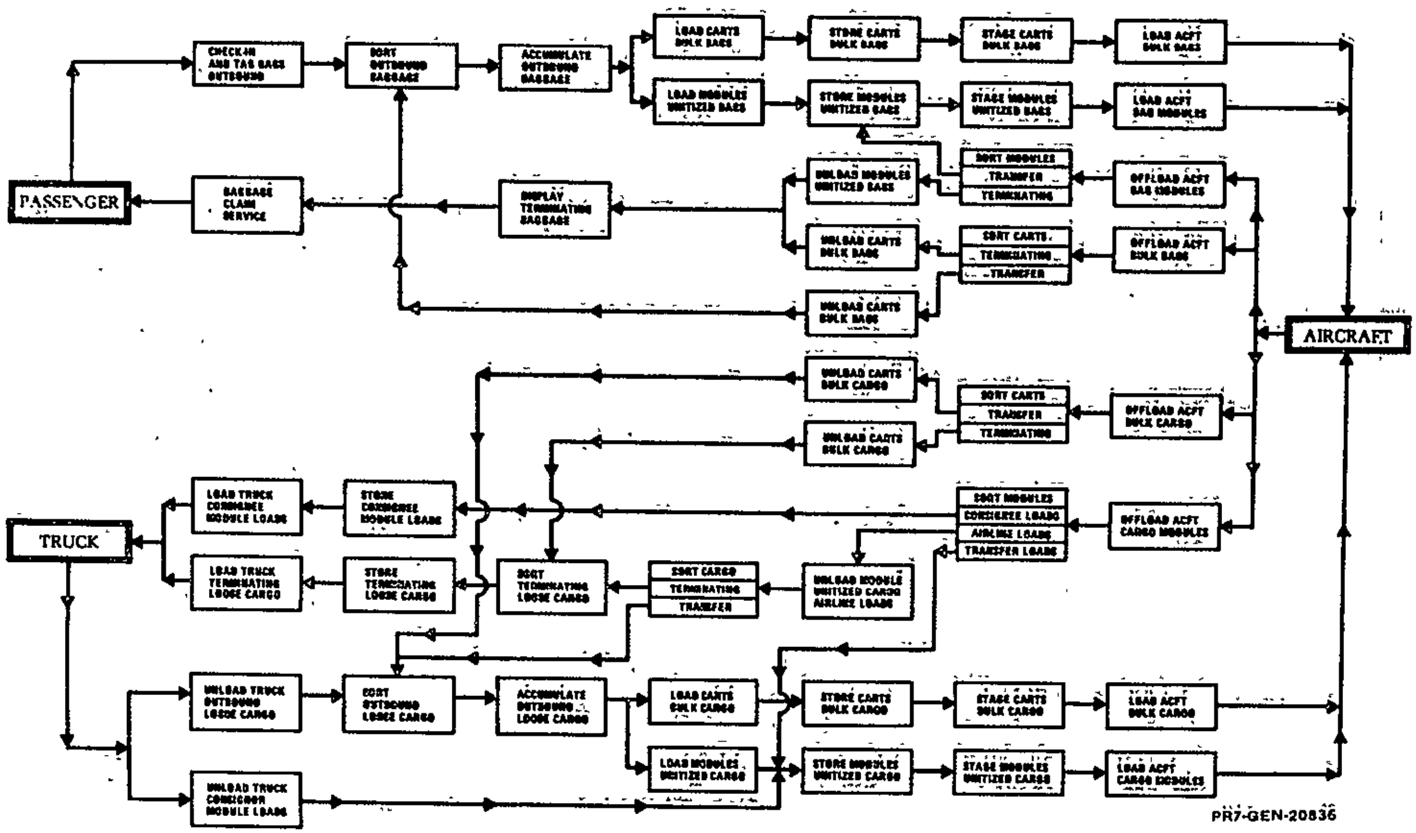

Figure 3-11. Baggage and Cargo Processing Functional Flow Model

simple concepts which permit addition of processing capabilities and increasing levels of mechanization when required by the system.

Present facilities and systems. - For evaluation of each terminal system, peak processing requirements are considered for each function and associated transport link within the flow model based on projected flow over a critical operating period. The operating period typically varies somewhat for different terminals, airports, and functions. Some process functions were observed to have a marked influence upon system requirements. Cargo storage is heavily dependent upon terminal area. This is particularly true for storage of terminating international cargo where dwell or storage time is many orders of magnitude greater than for terminating domestic cargo. Buildup and breakdown of loads are time dependent due to the pressures of meeting an outbound flight or of providing cargo when the consignee calls. These functions also relate strongly to area since room must be provided for moving cargo to and from the buildup and breakdown positions with a forklift. Cargo staging areas for outbound loads serve the purpose of an accumulator where cargo can be displayed and selected to build up an efficient load. This function is often slighted in terminal design. It is somewhat analagous to sorting inbound cargo after the breakdown operation in that area will be required to consolidate shipments from a mixed load. Last but not least, the functions for loading and offloading of air and surface transport vehicles require extensive area on their respective ramps to facilitate maneuvering and preclude congestion. Adequate truck docks and supporting personnel and equipment are essential during peak pickup and delivery hours. From the management system, it is necessary to know where a shipment is physically located throughout the total air cargo system.

Tables 3-4, 3-5, and 3-6 provide a summary of the major parameters for each of the surveyed terminals. These data are supplemented by an overall description of the operations for each function.

Truck load/offload: All but one terminal were equipped with depressed truck ramps which brought truck bed height nearly even with terminal floor

TABLE 3-4

TERMINAL PARAMETERS

Carrier	Truck Docks	Number Aircraft Positions	Total Man Hours Per Month	Number Men	Cargo Flow Per Month	
					Maximum - kg	Minimum - kg
1	29	4	25 569	135	5 357 553	4 914 303
2	32	4	48 980	265	4 829 519	4 311 607
3	37	2(47) or 3(8)	37 396	205	4 795 257	4 287 234
4	28	3	-	Contract	1 119 836	1 062 185
5	3	4	6 574	38	2 215 255	1 410 658
6	6	3	10 380	60	3 452 153	2 336 907
7	2	1	4 498	26	745 706	474 004
8	1	3	1 903	11	525 260	224 528
9	14	4	7 266	42	3 234 359	2 409 074
10	37	3(47) or 7(07)	105 237	729	8 808 588	6 654 790
11	5	1	7 977	44	2 197 477	1 736 552
12	15	0	13 518	78	1 268 471	857 439
13	44	4	-	-	-	-
14	46	3	66 661	384	4 898 797	4 127 690
15	24	2	30 275	175	3 723 844	2 250 461
16	15	0	-	133	8 082 046	1 727 360
17	5	0	-	-	4 092 329	713 621
18	43	3	-	160	-	-
19	69	4	-	-	15 092 833	11 408 755

TABLE 3-5

TERMINAL PARAMETERS - AREA

Carrier	Ramp Area M^2	Staging and Building/ Breakdown Position or Area M^2	Terminating Storage Area M^2	Terminal Area M^2	Land Parcel Total Area M^2
1	13 169	920/ 845	1 075	4 779	26 165
2	17 567	929/ 743	650	7 660	35 335
3	28 170	743/ 632	1 115	5 514	39 733
4	26 761	743/ 325	1 068	4 862	35 190
5	23 248	232/ 232	1 394	3 950	3 950
6	22 244	-	-	3 956	34 532
7	3 716	167/ 167	56	1 301	1 446
8	9 290	149/ 149	111	557	9 847
9	4 645	-	-	4 162	11 262
10	41 190	3 670/ 706	929	14 736	79 430
11	4 903	167/ 167	437	1 184	7 212
12	23 712	223/ 223	915	2 648	36 099
13	10 776	1 301/ 920	3 716	5 388	42 446
14	13 285	1 997/2 090	1 394	5 611	21 367
15	2 787	836/ 650	883	3 530	19 323
16	4 100	1 882/1 189	895	9 792	13 925
17	20 066	-	-	2 264	-
18	-	10 positions	30 positions	-	-
19	26 662	2 694/2 415	3 716	11 891	74 320

TABLE 3-6

SHIPPER-LOADED ULD FLOW

Carrier	Cargo Flow kg/Month	% Total Flow	Shipments per Month	% Total Shipments
1	2 433 784	47.71	1138	13.63
2	1 602 561	35.50	772	7.93
3	1 857 895	41.44	1173	11.65
4	484 372	50.82	203	10.65
5	1 118 559	78.54	339	38.02
6	1 665 100	68.74	666	31.25
7	305 154	60.55	179	20.67
8	68 530	32.20	43	12.70
9	1 272 138	53.92	706	24.48
10	859 167	10.00	3750	10.30
11	-	-	-	-
12	-	-	-	-
13	-	-	-	-
14	907 941	20.00	-	-
15	150 079	5.26	131	0.90
16	-	-	-	-
17	-	-	-	-
18	-	-	-	-
19	7 506 727	66.00	6622	16.77
20	352 589	14.00	138	4.02
21	291 331	23.88	131	4.10
22	547 259	40.03	175	7.41

height for bulk cargo handling. Most of these terminals were also equipped with dock boards to facilitate the smooth transfer of cargo between terminal and truck using hand carts, pallet walkers, and forklifts. Certain of these terminals also had dock positions at common ramp/floor height to facilitate loading and offloading of small vehicles (vans, pickup trucks, station wagons). Large trucks would sometimes use these locations if other dock positions were full. Then, as with the terminal without the depressed ramp, cargo had to be forklifted between the truck bed and ground levels. This was a slow process, usually tying up a forklift and operator along with the truck driver for extended periods. Large pieces of cargo were extremely difficult to handle under these circumstances.

Some facilities at LAX lacked sufficient truck dock maneuvering space and were hampered by traffic congestion. Generally, most dock ramps were adequate but had insufficient parking facilities. This caused trucks to queue and, in some cases, congest the service roads. Sometimes the only available parking for the carriers' own trucks was at inbound or outbound docks, reducing the doors available for pickup and delivery activities. In general, larger terminals had an abundance of dock positions, but used only a fraction (3 to 5) due to manpower limitations within the terminal. Trucks were observed to wait at the dock from 10 to 30 minutes before terminal personnel were available to accept the shipment. In other cases, docks were tied up 30 minutes or longer while a "gypsy" trucker sorted through the shipments, prepared airbills, and finally tendered the shipment. These small operators, who provide limited pickup and delivery service, should be required to have their business in order before parking at a dock position. If the carrier continues to handle "gypsy" truckers and private party shipments, ramps or docks should be provided for low-level truck and station wagon beds to minimize multiple handling.

Originating bulk cargo was either placed on warehouse pallets (large and/or heavy shipments) or on hand carts (single pieces, small shipments) by the trucker on the dock receiving platform at each surveyed station. The airline cargo handler used this time to review the airbill and any other documentation (export declaration) to determine that the paperwork was in order and whether any special handling was required (hazardous, high value, etc.). Acceptance of hazardous cargo is a time-consuming process even for trained terminal personnel who are handling these items daily. Regulations change regularly and penalties are high for mishandling. Some operators questioned whether the revenue on hazardous cargo justified the handling costs. For small stations which do not have a consistent flow of hazardous materials and face problems in maintaining proficiency in their personnel, a service agency on the airport could be of assistance in processing hazardous cargo on a contract basis.

Once the bulk cargo was on the dock, certain stations weighed every shipment. Other stations only weighed shipments which had no weight declared on the airbill. Some stations weighed a shipment only if the cargo handler suspected that the weight was too low or that the shipment would qualify for the cube rule. However, application of the cube rule was not observed to be applied with any vigor for two reasons: the handler was normally too busy; the airline did not provide measuring devices. In some stations, the scales were either inconveniently located or inoperative, and no weighing operations were observed. Weighing cargo as part of the acceptance procedure is time consuming. It can generate additional revenue for the airline, but it can also cause some consignors to do their business elsewhere (less cost and delay). If a terminal is not equipped with a scale which is capable of weighing a complete ULD before aircraft loading, it is essential to weigh each shipment and develop aircraft loads through cumulative totals of the shipment weights. Stations which do not weigh most shipments will weigh the complete ULD load. If there is a significant deviation between the actual ULD load and the cumulative airbill weights, the downline station will be requested to weigh the shipments in that particular load upon breakdown and correct the erroneous airbill weight. This can slow down the cargo retrieval process and can become complicated if a large shipment was split between two or more ULDs. Weighing procedures are variable by airline and even between stations in an airline.

Certain other system procedures reduce dock processing efficiency for originating cargo. At some stations, the cargo handler accepted the cargo and then pushed the hand cart, or forklifted the cargo, to the staging area for later loading by a separate crew, or loaded the cargo himself directly into the ULD. Direct loading reduces dock processing efficiency, particularly with large shipments which are time consuming to load. Small shipments also reduced dock processing efficiency, for the dockman would push the hand cart to the buildup staging area with only a single piece. This procedure was not too critical if the trucks were being interchanged, but it was observed to occur during acceptance of multiple small shipments from the same truck. Destination collection bins should be placed close to the operating truck docks and moved to the buildup area only when full or at a set time increment before cutoff. At other stations, the cargo handler at the dock only accepted the cargo. Hence, the dock man was able to work several truck positions at one time. Separate cargo handlers moved the shipments to the staging area. While this procedure was generally more efficient, the dock could quickly become flooded with cargo if the handler was delayed for some reason. Double handling of cargo also resulted when the handler failed to keep a supply of warehouse pallets and hand carts at the truck docks. The trucker would simply stack the cargo on the floor, thereby requiring the handler or dockman to load the pallet or cart. Similar problems with small-piece shipments were also observed with this procedure. The destination bin concept would also improve the efficiency of this dock processing procedure.

Two terminals had manual or powered transfer systems which permitted an aircraft ULD to be moved to certain truck dock positions for direct transfer of large shipments. Other terminals were simplistic enough in concept that ULDs could be brought to the truck dock on dollies for direct loading or offloading. Since large shipments were often composed of relatively uniform packages, ULD buildup direct from the truck does not reduce load efficiency. Direct transfer of large shipments significantly reduces the man-hours involved in the total processing system, although dock efficiency might be slightly lower. The major drawback with direct transfer occurs with originating shipment piece count. In the event that the trucker and cargo handler had different piece counts when the ULD was loaded it could only be resolved by offloading the ULD and recounting the pieces. Intermediate piece count checks by both parties could resolve the potential problem.

More than 90 percent of the terminals were equipped with consignor-loaded container (CLC) bypass systems to transfer aircraft ULDs between trucks and the terminal container storage system. The truck bed must be equipped with roller conveyors and restraint devices. In the regions which have severe weather conditions, the containers are normally carried inside of a van. Transfer of a Type A container between the truck and bypass system can normally be accomplished in 3 minutes, yet transfer times of 10 minutes were not uncommon. The delays may result from many factors:

- Incorrect ramp slope
- Damaged pallet base
- Inoperative/poorly maintained/makeshift truck roller bed
- Container shift into van sidewall
- Damaged container sidewall interference with van.

Most trucks were not equipped with powered roller systems, so pinch bars were often used to free the container. Some attempts were made to free containers using a cable and a winch or some other piece of powered equipment; however, this usually resulted in pulling apart the container. One of the more effective methods to free a container was to apply the mass-momentum principle through a series of quick stops and starts with the truck. As container sizes and loads increase, efficient CLC operations will require better quality truck transfer systems, probably powered.

Bypass systems were quite varied in design at all terminals and, in all but one case, were not conceived as an initial element in the terminal system. The most simple bypass system involved nothing more than roller conveyors on a lifting bed with a short 20-inch-high conveyor section which established an interface with a pallet dolly or transporter. In other cases, the truck interfaced directly with the elevating transfer vehicle (ETV) for the pallet stacker system. Several terminals had separate transfer vehicles capable of serving several truck docks and staging channels. Most terminal bypass systems were powered and included a scale either on the lifting bed, transfer vehicle, or adjacent roller conveyor section. The latter weighing position generally reduced the efficiency of the bypass operation since additional handling time was required. Because of their add-on condition, the location of the bypass systems was not always optimum. Many were located on the side of the building, and one was completely on the aircraft ramp. Better integration and higher mechanization of the bypass systems will result as the CLC business grows.

Table 3-6 provides a summary of CLC flow for those terminals which provided data. The range is from 5.3 percent and 1 percent, respectively, of the weight and shipments up to 78.5 percent and 38 percent. Airline emphasis and routes served are major factors in the level of CLC business. International cargo movement in CLCs is just beginning to become established.

Cargo sortation: All outbound bulk cargo was manually sorted in the surveyed terminals. Originating cargo was sorted on the truck dock by destination, flight, and handling requirements. It was then transported to the appropriate outbound staging area. Similarly, inbound cargo was manually sorted during breakdown of the trailer (bulk cargo) or ULD (unitized cargo) loads, verified against the load manifest, and matched with the appropriate airbill. Terminating cargo was moved to storage, and transfer cargo was transported to the appropriate outbound staging area. In all cases but one, cargo movement was by forklift or hand cart. A towveyor system was used to a limited extent at one terminal to transport cargo between functional areas. The towveyor could not carry all shipment sizes due to cart limitations or limited cross movements and was relatively inefficient in terms of speed and delivery reliability. The existing air cargo system and mechanized sorting systems are incompatible except for limited special cases. Mechanized sorting systems require high flow rates of relatively small, uniform packages. An operator must closely control the volume, weight, and dimensions of the cargo which is accepted in order to stay within the tolerances of the mechanized sorting system. A typical current air cargo terminal in the U.S. would have too little small-piece cargo for mechanized sorting once consideration was given to maintaining the integrity of large shipments with many small pieces and maintaining the integrity of shipments with a mixture of large and small pieces. Separation of the small pieces usable on the mechanical sorter would be an additive task to present manual sorting operations. To achieve a flow rate of at least several thousand small packages over a typical 4- to 6-hour processing period, cargo from many individual terminals would have to be processed at a major hub terminal. A hub terminal can provide benefits in processing and routing efficiency but increases the risks associated with system failure and capital investment. Efficient utilization of mechanized sorting systems may require flow as high as 40 000 packages per hour.

The general trend in U.S. air cargo has been to eliminate as much piece handling as possible while encouraging freight forwarders and major shippers to tender CLCs. United Parcel Service, a major factor in CLCs, has a nationwide network with regional hub terminals to facilitate processing and distribution of small pieces. Federal Express has gone counter to the air cargo trend by exploiting small-package express service. Again, nationwide service and hub terminals with mechanical assist sorting are the key to success. Of two mechanized sorting systems in U.S. air cargo terminals, one has definitely been abandoned because the size of shipments and pieces rapidly exceeded the capability of the system. Mechanized sorting systems have been installed in hub air cargo terminals in Europe which process cargo from their operator's entire system over limited time periods. However, Douglas cargo surveys found that in comparison to U.S. air cargo, European pieces were 18-19 percent smaller in volume and weight, shipments were 35-37 percent smaller, and there were 22 percent fewer pieces per shipment (Reference 3-1). Several air cargo terminals in the U.S. had manual sorting with mechanical assist, but a significant amount of cargo bypassed the system due to piece size or shipment integrity. In general, any form of mechanized sorting of general air cargo requires significant flow segregation and high flow levels to achieve moderate effectiveness.

Accumulation of outbound bulk cargo: This storage and staging function occurred after cargo sortation and before load build activities. Most cargo was accumulated in areas (designated by destination) adjoining the buildup locations. If the terminal served both passenger and freighter aircraft, there was at least limited segregation of the accumulation and/or buildup areas. All of the surveyed terminals accumulated cargo on the floor using warehouse pallets or hand carts to maintain shipment integrity. The accumulation continued until an established time was reached to start load buildup.

The total time period for accumulation depended upon the correlation of truck delivery schedules, inbound flight schedules (transfer cargo), and outbound flight schedules. The accumulation period for domestic cargo was measured in hours with some shipments arriving directly at cutoff. The period for international cargo could range from hours to a week. Interline transfer cargo was accumulated in separate areas and segregated for regular delivery to the ongoing carrier.

As cargo accumulated prior to buildup operations, approximately 80 percent of the surveyed stations reached saturation in the bulk cargo storage/staging area. Destination segregation disappeared. Access to desired shipments and pieces for load buildup was virtually impossible without multiple handling. Several times ULDs were partially offloaded to load a shipment which had to travel on the particular flight, but had been hidden in the queue. Cargo selectivity is critical to achieve efficient aircraft loads, but is area intensive. Few terminals have been designed with adequate floor area for staging outbound bulk cargo. One approach to the problem of limited area is to use direct loading (truck to ULD) or modifications thereof. Large shipments with uniform pieces are ideal for loading from truck to ULD at the the truck dock. As the shipments become less homogeneous and/or smaller, direct loading involves movement of the cargo from the truck dock directly into the ULD. This process reduces selectivity and produces less efficient loads, although the degree of inefficiency can be reduced through buildup of multiple ULDs to a single destination.

The area required for cargo staging and the time required to build up loads can both be reduced through minor equipment and procedural changes.

- Large pieces and/or shipments which form the base load in a ULD should be loaded immediately upon receipt. If the shipment is not scheduled for immediate departure, the partial load can be stored in the ULD stacker system or on other storage devices away from the main stream of terminal activity until final loading is required. In most terminals, manpower was available to accomplish this task, but was not assigned the duty.

- A small team should be assigned to handle staging and buildup operations to ensure efficient loads and to maintain control over the cargo loaded. The team could be supplemented with other personnel as closeout time approaches. As some personnel have the knack for receiving cargo at the truck dock, this team must have the inherent feel for load buildup.
- Small shipments with small pieces should be consolidated in bins at the truck dock receiving area. The full bins could then be moved to the appropriate destination staging area and stacked, either on racks or with internal supports, until top-off cargo was required for the load.
- Medium shipments are normally placed on warehouse pallets to maintain shipment integrity and to facilitate movement with a forklift. The next logical step is to place these shipments in racks by destination when loading will not be required for several hours or longer.
- Staging areas should have at least two to three times the base area of the ULD plus access aisles to facilitate cargo selectivity. Staged cargo should be visible from and close to the buildup area to facilitate selectivity.

Load buildup: Extensive planning is required to develop loads which are efficient in terms of weight and cube utilization, are compatible with handling operations at downline stations, are consistent with aircraft characteristics, and are providing the quality of service desired by the consignor and consignee. A decision must be made on whether a shipment will be unitized or handled as bulk cargo. A decision must be made whether to unitize the load in a main-deck or lower-deck module. A decision must be made as to the type and size of ULD which will be used on either the main or lower deck. Cargo stackability, compatibility, and special-handling requirements must also enter into the decision-making process.

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Buildup of loads of bulk cargo was normally accomplished in freight carts designated by destination and/or flight. In some instances, bins or aircraft pallets were used to consolidate the bulk cargo. Since bulk cargo will be manually loaded into aircraft belly compartments, it is generally composed of smaller than average pieces. However, if service to a given destination can only be provided by passenger aircraft belly compartment, the pieces may be very large, several hundred kilograms and up to the maximum dimensions which can be accommodated through the door. Human remains at a mean of 0.8 cubic meter and 138 kilograms represent large pieces which are consistently transported in the aircraft bulk compartment (Reference 3-1). Cut flowers, live animals, and newspapers are other examples of bulk compartment cargo. Due to the relatively small size of the bulk compartment cargo, this cargo was seldom staged. Rather, it was loaded directly into the freight cart to minimize multiple handling. Freight carts were loaded with bulk cargo on the cargo terminal ramp at approximately 53 percent of the surveyed stations due to space limitations in the buildings. This procedure provides less than optimum security and weather protection for the bulk cargo. Forkliftable bins with weather/security closures and cart interface fittings provide an alternative means of consolidating bulk compartment cargo in limited building areas, yet allow relatively secure staging and storage when mounted on carts on the ramp.

Buildup of unitized loads was accomplished in a number of ways, all of which were essentially integrated with ULD storage, staging, and aircraft loading functions. The most flexible and area-intensive method of load buildup was accomplished with the main and/or lower deck ULD restrained on a pallet or container dolly. When space was available, the dollies were positioned within the terminal. Otherwise, the dollies were positioned on the terminal ramp with the attendant potential for pilferage and weather damage to the cargo. The dolly provides a relatively inexpensive device for transporting, storing, staging, and transferring the ULD from buildup through aircraft loading with only a tug and operator. For efficient operations, proper management of dolly positions is essential. Several terminal operations were observed where dolly positions were not controlled, and the effort expended for load buildup was out of proportion to the task. Staged cargo was not accessible. A loaded ULD could not be moved to the staging area without moving other dollies involving partially loaded modules. Access aisles were partially blocked, thereby, restricting normal terminal cargo movement operations. Dollies must be positioned with access to and from the staged cargo, with access for forklift loading, and with access for dolly removal.

Conveyorized racks were also used for load buildup, primarily with ULDs of 2.2 x 3.2 meters or larger base dimensions. A few instances of load buildup operations were viewed on free-standing 51-centimeter high racks. ULDs were transported to and from the free-standing racks with powered transporters (friction drive) or manually with dollies. Buildup racks were most often integrated with the ULD stacker and/or transport systems. Normal orientation for the ULD on the buildup rack was with the 3.2-meter face parallel to the stacker or transport system. This orientation facilitated loading of the Type A, M-1, LD-7 and LD-9 containers and maximized the number of buildup positions. However, it was usually necessary to rotate the ULD at some other point in the system for compatibility with aircraft loading or transporting equipment. This concept also negated the inherent advantage of pallets having loading capability on all four sides. This flexibility is of some value when loading large, bulky cargo items. Further, this concept tends to reduce the width of the cargo staging area to less than 3.2 meters. Some stacker systems orient ULDs such that the 3.2-meter loading face of the container is perpendicular to the stacker. Buildup racks were then normally arranged in back-to-back pairs with two or more empty positions before the next pair for a loading zone. This second concept severely limited the number of buildup positions and created congestion in the loading zone, particularly when large cargo items were loaded and/or a minimum loading zone was provided. This second concept permitted pallet loading from two sides, provided correct ULD orientation for aircraft loading, and could establish more usable cargo staging area. In cases where this second stacker system was employed, part or all of the buildup operations were conducted remote from the stacker system to gain more buildup positions.

Buildup operations for lower-deck containers were usually conducted on dollies, but in some cases the smaller containers were placed on the floor. Some LD-5 and LD-3 containers facilitate floor loading since they are equipped with bases which permit forklift handling. Other containers without forklift provisions were stored and loaded on the floor. To place the container back in the system, it is necessary to force the forklift blades under the pallet base. This action, along with the resulting movement across the floor, damages the pallet which eventually causes handling delays or damage to the aircraft and ground handling equipment. Improper handling of containers by consignors is often considered to be a major cause of damage, but survey observations also noted frequent examples of improper container handling in the airline terminals.

Cargo terminals are not presently equipped with integrated buildup positions for the new 2.4- x 6.1-meter pallets and 2.4- x 2.4- x 6.1-meter containers. The new large container has the advantage over other ULDs used in air cargo in that it can be loaded while on a trailer chassis at any truck dock. Hence, load buildup operations were conducted at the cargo terminal delivery truck docks. This procedure created some congestion with normal receiving operations, but was acceptable. The large pallets were used primarily for large pieces of machinery which were oversize to a normal aircraft pallet. Buildup of many standard all-large aircraft pallets was normally conducted on the cargo terminal aircraft ramp area since greater accessibility for buildup operations was available. Standard pallets were placed on racks or dollies while the large pallets were positioned on racks or trailer chassis. At present, only one cargo terminal at JFK has a scale capable of weighing loads in 6.1-meter ULDs. If large cargo pieces and consignor loaded 6.1-meter containers continue to expand in the future, air cargo terminals will require more sophisticated heavy-duty equipment to facilitate container transfer and load buildup operations.

Reserved airfreight influences buildup and closeout of ULDs. Reserved cargo,like priority,often arrives late and containers are kept open until the last possible moment in order to accommodate it. Major shipments of reserved cargo are usually known before hand and accounted for as they arrive in order to close out ULDs as soon as possible. Holding a container open until cutoff to ensure that reserved cargo can be loaded often precludes loading lower-priority cargo. This lower-priority cargo, which has backed up, must go out on the next flight. Weight and balance is developed using typical loads by destination as modified by reserved freight.

Load/storage/staging: Loads for aircraft bulk compartments were stored and staged in freight trailers or similar devices on the aircraft ramp at all but one terminal visited by the team. LD-3 container loads were stored and staged on dollies at all but several terminals which used conveyorized storage racks. The large 6.1-meter-long container and pallet loads were stored and staged on racks and/or trailer chassis. Half of the surveyed terminals employed dollies and/or racks on the aircraft ramp for storage of all other ULDs. Normally racks were used to interface with transporter vehicles. Both racks and dollies were employed at some terminals. The racks were used for storage with manual transfer to the dollies for aircraft loading.

The other half of the terminals used mechanized systems such as stackers and/or powered conveyors (raceways) to store, transport, and stage loads. At all but one terminal, the raceways interfaced with a form of stacker system at some point in the outbound cycle. At the exception, series of powered storage channels and a transfer vehicle interfaced with the raceway and provided selectivity for aircraft loading. Stackers are the most expensive subsystem in a terminal processing system, but maximize storage for a given floor area through use of available or allowable terminal and ramp clearance height. The two- and three-level-high storage compartments were served by one or more elevating transfer vehicles (ETVs). After load buildup, the ULDs were placed into storage in the stacker compartments and withdrawn in the sequence required for aircraft loading.

In the past, stacker systems had to be relatively large to justify two ETVs from a functional standpoint and to achieve reliability in case of system failure. Smaller terminal operations can also benefit from stacker systems now when floor area is limited. Adjoining terminals were observed where the stacker system for both was common, but separated by doors. In the event that an ETV failed in one terminal, the ETV in the second terminal could be borrowed simply by opening the doors. Some of the newer ETVs have dual-drive systems so that they can continue to operate at half speed in case of drive failure. Most stacker systems were noted as having good reliability, or at least not having failed during critical operating periods. Others were in the process of being modified to provide greater dependability.

The introduction of ULDs with 2.4- x 2.4-meter cross sections have required those terminals serving wide-body freighters to procure new or modify old equipment such as dollies, transporters, raceways, ETVs, and stacker compartments. A limited number of stacker compartments have been provided at some stations for storage of 2.4- x 3.0-meter-high cross-section loads. These compartments were achieved by reducing the height of the next compartment in the stack such that it was compatible with lower-deck ULDs. Interesting modifications to a stacker system were observed which permit efficient storage of empty aircraft pallets. This small but constant problem was solved by installing a series of small roller conveyor shelves within a stacker compartment.

At some point between load buildup and aircraft loading, the load was usually weighed to permit accurate determination of aircraft weight and balance. Those terminals utilizing dollies were usually equipped with floor scales. When transporters and racks were employed, the scale was normally integrated into a rack section. Raceway systems usually had a scale integrated into several positions in the flow path. Scale location was varied with stacker systems, either on the ETV or on several input/output spurs. Mixed opinions were received on the reliability of scales by type and location, but no trend could be established.

CLC inputs to the outbound storage and staging system were consistent with the ULD transportation and storage system used throughout the terminal.

Aircraft offload/onload: Passenger and combination (combi) aircraft ramp operations are conducted at the passenger terminal. Allowances for transportation between passenger and cargo terminals ranged from 15 to 30 minutes depending upon the airport and terminal location. Time to make the trip must be adjusted from the norm to account for weather and operating (peak or valley) density. The handling priority on passenger aircraft is baggage, mail, and freight with the new priority or express service parcels processed along with baggage. When time for ramp operations is constrained as with a late arrival, outbound freight may not be loaded. The freight must then be retained at the passenger terminal for the next flight to the noted destination or returned to the cargo terminal for possible breakdown and buildup as required for the next flight. Passengers and baggage introduce more variables into load planning than with a pure freighter operation. If the passenger and/or baggage load is higher than predicted, all the planned cargo may not be loaded and consideration must be given to priority of what can be loaded. Conversely, if the passenger and baggage load are lighter than planned, additional cargo could be loaded if available. Transportation constraints would normally preclude running extra cargo to the passenger terminal. For this reason, some airlines maintain a bank of cargo at the passenger terminal for loading on a space- and time-available basis.

The minimum period of time between aircraft departure and final acceptance of cargo for that flight at the truck dock is called cutoff time. The time period must allow enough time to process the cargo and documentation, transport the cargo to the aircraft ramp, and load the cargo on the aircraft. Cutoff time varies by airline, location, and type of cargo (bulk or CLC), flight service (domestic or international), and operation (passenger or freighter). Bulk cargo for a domestic passenger or freighter flight must normally be received from 1 to 1.5 hours prior to departure. The two are equivalent since transport time to the passenger terminal is comparable to longer buildup times for the larger freighter ULDs. CLC cargo for a domestic passenger flight must normally be received from 0.75 to 1.0 hours before departure, while CLC cargo for freighter aircraft will be accepted from 0.5 to 1.0 hours before departure. Cutoff time for CLC operations is minimal since virtually all processing steps are bypassed. If the shipper calls in the weight of the CLC, weight and balance for the aircraft can be computed and a position allotted near the cargo door for loading the unit near the end of the onload process. The slight difference between cutoff times for CLC operations with passenger and freighter aircraft is related to transport time between terminals. Cutoff times for international flights were found to be based primarily on documentation processing. Times ranged from 2 to 4 hours for both aircraft and cargo load types, although some stations allowed from 0.5- to 1-hour reduction in cutoff times for CLC loads.

Offload and onload for every aircraft involve lower-deck (belly-pit) operations with mobile equipment. Bulk baggage and cargo are normally carried on narrow-body passenger aircraft, and bulk cargo is normally carried in the belly compartment of narrow-body freighter aircraft. Bulk cargo and/or baggage may be transferred directly between the belly compartment and freight trailers or by a mobile powered-belt conveyor. Working as a team with personnel on the ramp, the crew in the belly compartment stacks freight, mail, and baggage by destination and by priority. Some airlines use small containers (1.7 to 2.3 cubic meters) in narrow-body passenger aircraft for baggage and to a lesser extent for cargo. The containers are loaded either with a system integral to the aircraft or with small mobile loaders. Wide-body passenger and freighter aircraft have two major lower-deck compartments for ULDs and a smaller bulk compartment. The bulk compartment may contain a variety of baggage and cargo items. Baggage is primarily carried in LD-3 containers, but sometimes special baggage items, such as skis, are carried in LD-5 containers. Cargo may be carried in LD-1, LD-3, LD-5, LD-6, LD-7, LD-9 and LD-11 containers or on aircraft pallets. The selection is dependent upon a number of variables such as aircraft door size, shipper requirements, destination load size, and airline equipment inventory. Mobile loaders with approximately 7000 kilograms capacity are used for offload/onload of ULDs. Transporters and/or dollies interface with the mobile loaders. Trailers and mobile belt conveyors are used for offload/onload operations with bulk cargo.

Main deck onload and offload operations for freighters are conducted with either mobile equipment or a fixed dock. During the survey, approximately 75 percent of the surveyed terminals used mobile ramp handling systems for narrow-body freighters and all used mobile ramp handling systems for the B747 freighter. At least one B747 freighter operator is using a fixed-nose dock system. A fixed dock for side door loading on the B747 freight would be impractical due to its location aft of the wing. Normally fixed-dock loading systems are integrated directly with the mechanized staging and storage systems within the terminal system. The dock may interface directly with the stacker and ETV. It may contain its own mini stacker and ETV system and be connected to other terminal processing functions by a raceway. On each dock, the loader platform has limited adjustment capability to account for variations in aircraft position. With a mobile system, the main-deck loader accounts for aircraft variations through its positioning and platform adjustments. Transporters or dollies (pulled by tugs) transfer the unit loads between the terminal staging area and the loader.

A wide variety of dollies are used by airlines. They may be constructed with roller conveyors or caster beds for unidirectional or omnidirectional loading. They may provide for end and/or side load transfers. Depending upon the former, they can be loaded and offloaded singly or in train. They may be backed in or pushed into position with end or side hitches for the tugs if they are to handle loads one at a time. Load transfers between the dolly and loader may be powered by the use of chain-connected rollers on the dolly with friction drive from the loader platform. More commonly, the load transfers are accomplished manually. The impulse momentum principle was commonly observed to feed ULDs far enough onto the loader bed until the powered loader rollers could continue the transfer. This sometimes resulted in damage to the ULD, and when the principle was employed to complete the load transfer onto the dolly; one instance was observed where the entire loaded ULD was dumped onto the ramp. Better practice is to have one or two men available to help the tug operator transfer loads between the loader and dolly. Dollies provide a very flexible operation in that they can be used for buildup, storage, staging, transportation, transfer (with loaders and fixed storage equipment) and breakdown activities. A system employing dollies throughout requires significant floor and ramp area.

If properly designed, dollies can be towed in trains of four or five units to aircraft ramp areas which are remote from the terminal. While dollies can support necessary remote operations, long-distance hauls can be both time consuming and a source of congestion on airport service roads since dolly train speeds are limited to approximately 8 kilometers/hour. Some airlines employ trucks or truck-trailer combinations with bed lengths of approximately 6.7 and 13.4 meters to respectively handle two and four standard aircraft ULDs or one and two of the larger 6.1-meter-long ULDs. Normally the trucks have roller conveyor beds. Some of the trailers have powered transfer capability, using electrical sources on the loader or at the terminal. The over-the-road capability of the trucks is much better than with dolly trains. However, their potential may not always be realized due to service road congestion from other slower moving vehicles.

Approximately half of the surveyed terminals employing mobile ramp handling systems used transporters to facilitate transfer of ULDs between the loader and fixed terminal storage/staging equipment. The distances were normally quite short. Most transporters handled only one standard aircraft ULD, although some had the capability for two standard or one large ULD. Transporters provide powered transfer capability for ULDs and, therefore, can reduce manpower requirements on the ramp. In conjunction with fixed storage/staging equipment, a transporter operation is less area intensive than a dolly system. However, operators using dollies characterized transporters as unreliable, expensive to maintain, and high in initial investment. Stations which employed transporters were generally pleased with their operations.

The relative merits of fixed versus mobile systems are open to debate. Facility limitations may determine which type of ramp handling system is employed. In certain instances, more aircraft can be handled on a ramp using mobile equipment, or aircraft access to and from the ramp may favor operations using mobile equipment. Capital availabilty may determine which system is employed. Mobile ramp systems are generally less expensive than fixed-dock systems when considered as a separate element. However, if the flow level or other considerations are such that mechanized terminal processing can be justified, the fixed dock can be readily integrated as part of the total system. Total cost would show little variation under such conditions regardless of the ramp system. A fixed-dock system would be slightly more efficient than mobile ramp handling systems under adverse weather conditions. The fixed systems can be more easily protected. Mobile systems, on the other hand, are less constrained with respect to the size of cargo items which can be handled. The inherent adaptability of mobile systems may permit more rapid recovery of operating schedules in case one piece of equipment fails or permit a change in the priority of aircraft onload-offload cycles in the event that flight operations become snarled. Conversely, a fixed dock can be more ruggedly constructed with fewer operating items than a mobile loader, so it should have higher inherent reliability. Mobile systems provide greater flexibility in ramp utilization. When flight schedules permit, several airline operators in adjacent terminals can share the same ramp area more readily than if fixed docks were installed. With the extent of terminal system mechanization at present, most airlines are using mobile ramp handling systems for main deck ULD onload-offload activities.

All wide-body aircraft have powered loading systems in the forward and center lower deck compartments to facilitate ULD handling. B747 freighter aircraft have powered handling systems on the main deck. Narrow-body freighter aircraft used by two domestic airlines have powered handling systems on the main deck. Powered loading systems provide little if any benefit in handling times when compared with manual systems. Due to the cyclical nature of operations with either fixed or mobile ramp handling systems, the ground system lags the aircraft operation for ULDs located near the aircraft door while the reverse is true for operations when the ULDs are furthest from the door. Powered loading systems could provide significant time savings if complete stream offload-onload capability were provided by the aircraft and ground systems using fixed docks for main deck operations. However, the capital investment for such a ground system would be extensive. Rather, powered loading systems permit a reduction in manpower to handle a given load. In addition to the loader operator, three to four men were observed to be required for manual handling of standard main deck ULDs. Two men plus the loader operator were normally employed to handle main deck ULDs with powered systems, although one man and the loader operator did operate the system at nearly the same level of efficiency on some occasions. Powered systems on the lower deck were operated solely by the loader operator. The technology is available and tested at Douglas Aircraft Company for a powered main-deck handling system which can also be operated by a single man. As with most increases in mechanization, operation is based on ULDs with standard AS-832 bases for consistent latching patterns. Finally, powered loading systems permit offload-onload operations on the main deck of wide-body freighters which would be virtually impossible for any size crew, if manning levels permitted. The maximum weight of a 2.4- x 6.1-meter ULD is 11 338 kilograms up to 18 140 kilograms for a 2.4- x 12.2-meter ULD.

The efficiency of offload-onload ramp operations depends upon the condition of the ULDs and of the inbound and outbound storage/staging systems as much as it depends upon the type and condition of the ramp handling system. A poor pallet base will cause delays and/or damage to all elements in the processing system. As the weight of the load increases, the severity of the hangups also increases. If the staging/storage areas are congested or if any equipment is inadequate in quantity, quality, or maintenance standards, the offload-onload operation will reflect the weakest link. Maintenance on the equipment and training of personnel in equipment operation are extremely important in this functional area because of the direct interface with the aircraft and the urgency with which offload-onload operations are performed. The schedule is as important to the cargo system as it is to the passenger system.

Outbound documentation and control: When the aircraft departs from the ramp, all documentation is theoretically contained on a pouch in the aircraft. This is actually accomplished with some airlines and, of course, customs documentation is always shipped with the cargo. However, a strong trend was observed for airlines to process airbills and manifests over a computer network which connects their stations. This system is established domestically and is being implemented for international operations. All airlines surveyed had computer systems to facilitate centralized billing and accounting activities. Steps in the future may include computerized load planning and transmission of customs documentation along with the airbills. The computerized systems presently in use provide for more balanced clerical work loads in processing airbills and manifests because flight time can be used to complete and transmit the details. The computer also provides a powerful tool for tracking shipments when the manifesting, verification, and storage/staging tasks are integrated.

The documentation and control activities start before the cargo is physically received. When a consignor requests reserved space on a flight, the shipment is placed on one of the module load lists for a given flight on a given day. The airbill is verified when the shipment is received at the truck dock. A stencil or sticker is, with the exception of one airline, applied to each piece in the shipment to define the airbill number, destination, transfer stations, number of pieces, and total shipment weight. Machine printing should be used for the stencils or stickers to reduce the potential of misinterpreting carelessly written letters and numbers. Stickers are used by the excepted airline on all cargo which will be transferred, and all packages must provide the name and address of the consignee to facilitate shipment verification later in the system.

If the shipment holds reserved space, receipt of the shipment will be noted on the load list. Cargo holding reserved space receives priority in loading a ULD. If a large shipment is late arriving, buildup operations will be held back to ensure that the shipment has space, with the consequence that there may not be enough time for loading lower priority cargo. Utilization will suffer under these circumstances. Cargo without reservations is added to the load list or on-hand list as it is received at the dock and will generally be loaded in the order received and/or as space is available.

Some airlines keep the airbill with the shipment until it is loaded in a freight trailer or ULD. The airbills for the given module are collected periodically and identified by module number. The shipment is noted as loaded on the load list. With manual processing, the airbills would be grouped by flight and module numbers. A running manifest would be maintained. With a computer system, the airbill data along with flight and module numbers would be input to the system for later development and transmittal of the manifests and airbills to downline stations.

A variation on this procedure by other airlines is to submit the airbill directly to the office upon receipt of the cargo. The airbill data can be entered into the computer system over a longer time span with this procedure. A card is completed at the truck dock which contains the airbill number, origin and destination stations, number of pieces, weight, and certain other data. The card normally stays with the shipment until loaded. At that time, the module number is noted on the card and the shipment status is changed to loaded on the load list. The cards are collected periodically for input of the data to the computer system where the module number can be matched to the other airbill data. Hence, the manifesting function can be completed when required.

Greater control over outbound cargo is required as the flow, size, and complexity of the cargo-processing operation increases. The procedures noted above are most applicable to small to medium-sized domestic operations where the cargo simply flows through the terminal. The flow is interrupted in international terminals due to more diverse flight schedules and incomplete documentation. As operations expand, efficient control will require input of receipt, time, status (complete documentation, reserved or space available), and storage/staging location to the computer from a copy of the airbill. These data will provide computerized manifesting and airbill transmittal as at present and also permit continual update of flight and ULD load sheets. If volume and handling restrictions were included,module load planning tradeoffs could be conducted to achieve more efficient utilization. The cargo handler would have a detailed plan on what cargo to load, where to find the cargo, and perhaps the sequence of loading when buildup starts. Terminal management would have a continual inventory of the outbound cargo and its location. A copy of the airbill would remain with the shipment until loaded in a module. The module number would then be entered on the airbill for manifest development by the computer.

Inbound load sortation: As observed during offload operations, each ULD was verified against the flight manifest by ULD number and/or aircraft position to determine routing for further processing. Some carriers facilitated sorting by noting the weight destinations and transfer points on cards or chalk boards attached to the ULD. Terminating loads were directed to breakdown positions or to storage/staging positions depending upon the urgency of cargo retrieval and the availability of manpower and equipment. Terminating CLCs were normally routed directly to the inbound bypass system for consignee pickup. Transfer loads were placed into storage/staging positions on the ramp or in the terminal building. In some cases, the ULD transfer could be directly to a waiting aircraft. Ramp staging/storage was normally accomplished for loads which were continuing on the aircraft to a downline station. Offload of continuing loads could be required to gain access to other loads for weight and balance considerations or to realign the loads for offload operations at smaller downline stations. The storage/staging position of each ULD was recorded for control purposes.

Bulk cargo was handled in a variety of ways depending upon the airline, station, and operating condition. Sometimes transfer cargo was segregated from terminating cargo during aircraft offload on the ramp by using multiple freight trailers or devices. In other cases, no segregation was accomplished until the bulk loads reached the terminal. Large-bulk shipments were segregated from other smaller terminating shipments in several instances to minimize handling later in the processing system. Bulk cargo was checked against the manifest using airbill stickers or stencils on the cargo. These contain the airbill number, destination city or airport code, transfer points, number of pieces, and shipment weight. One airline only applies this information for transfer shipments, requiring that the consignor clearly identify the consignee's address. This procedure does save time on the receiving truck dock, but increases the potential for misrouting cargo, particularly bulk-loaded cargo.

Cargo breakdown/sortation: Inbound cargo was sorted manually while being unloaded from ULDs and freight trailers at all surveyed stations. For terminating cargo, the shipments were segregated, checked against the ULD or bulk manifest, and matched with the appropriate airbill. Any deviations were reported for clarification by upline stations which accepted or handled the shipment. Transfer shipments were segregated from terminating cargo in mixed loads and matched against the manifest. Transfer cargo was further separated into intraline and interline cargo. Some stations verify intraline transfer shipments only at the final (terminating) station with each transfer piece simply sorted by the next destination and added to the proper outbound manifests. Other stations will verify the intraline transfer shipment and note any deviations on the outbound manifest. Interline shipments normally required complete verification before the cargo was transferred to the next carrier. While intraline transfer cargo was simply input into the outbound network, interline cargo was consolidated by carrier for regular delivery.

An urgent shipment might be picked up by the ongoing carrier upon notification of its arrival at the transfer station.

Physical breakdown operations involved manual or forklift handling of the cargo depending upon piece size. In the larger terminals surveyed, breakdown positions were physically separated from the buildup stations. In smaller stations, buildup and breakdown activities used the same positions. Breakdown positions do require room for forklift positioning and for segregating the shipments on hand carts and warehouse bins and pallets, but the area required is somewhat less than for staging outbound cargo at the buildup positions. One major station had inadequate area for forklift positioning due to storage rack locations. Adjacent breakdown positions were used at another terminal when large shipments were contained on a ULD. As breakdown continued, the large shipment was stacked directly onto an aircraft pallet for storage in the stacker system upon completion of shipment verification.

Breakdown activities were scheduled based on retrieval urgency, equipment availability, and manpower availability. Prime-time freight forwarder cargo and transfer cargo were made available as soon as possible after arrival at domestic stations. Next in priority was cargo scheduled for truck delivery by the airline or Air Cargo, Inc., as well as reserved cargo for a major company. Will-call cargo had the lowest priority. While international cargo and off-hours domestic cargo were processed in a timely manner, there was not the same sense of urgency as related to domestic prime-time freight. Special cargo, such as perishables, valuables, and live animals, was processed with a sense of urgency since most terminals did not have extensive facilities to provide the unusual care required for these items. Shipment of a horse, for example, may involve advising the consignee several times during transit as to the progress, status, and time of arrival of the animal to ensure prompt and proper pickup.

When breakdown and buildup positions were shared, it was impossible to start breakdown activities until buildup activities were complete. Similarly, breakdown activities could not be initiated in terminals with separate buildup and breakdown positions until crews were available. The cyclical operation of

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cargo terminals, particularly domestic terminals, required careful manning to ensure that peaks were covered without excess manpower during inactive periods. Most airlines must use full-time personnel in 8-hour shifts to meet peaks that cover about 4 hours. Part-time personnel were curtailed by the unions at several terminals until full-time manning levels were consistent with past levels. Breakdown of less urgent cargo was often used to balance work load during slow periods.

Terminating bulk cargo storage: As breakdown was being performed, the verified shipments were placed into storage. The storage location was noted on the airbill or load manifest for each verified shipment. These data were passed to office personnel to maintain a record of the location of the shipment for consignee pickup activities at some later time. In domestic terminals, major consignees, such as freight forwarders, usually had standard storage locations in each location. Similarly, interline transfer shipments and terminating shipments with instructions for truck delivery to the consignee were also usually staged in standard locations by delivery route. Since much of this is prime-time domestic cargo, it spends less than several hours in storage. Cargo received during off hours will tend to require longer storage since it may be of lower urgency (will-call cargo) and will probably have missed normal delivery schedules. Total terminating domestic cargo was found to be stored an average of 5 hours.

Because of the short storage period for terminating domestic cargo, every surveyed terminal used hand carts and/or warehouse pallets on the floor for storage. Storage location referred to a cart number or floor zone painted on the floor. This approach can be efficient when area is available and when cargo flows through the area rather than accumulates in the area. During the surveys, the team observed that enough off-hours and will-call cargo accumulated during the day at several terminals to seriously retard flow through the storage area. After prime-time cargo was broken down, the storage area was immediately congested and operational efficiency was reduced. Some terminals did not physically separate inbound and outbound domestic cargo operations. In the case of these terminals, the residual terminating cargo constricted movement and display of the outbound cargo.

As flow levels increase, it will become increasingly essential to either expand the area for domestic terminating bulk cargo or to restructure operations to make use of available volume. With horizontal expansion limited at most locations, vertical expansion appears to be necessary.

Large shipments could be stored on warehouse pallets on aircraft pallets in the ULD stacker system. When requested by the consignee, the shipment could be removed from the stacker and moved to the truck dock for direct loading or the shipment could be forklifted to the truck dock on warehouse pallets from the stacker output channel. Residual terminating cargo could be stored on racks sized for small, medium, and large shipments. Large-piece shipments could be stored on a designated floor area or under the rack allocated for large and medium-sized shipments. Narrow-aisle electric reach fork trucks would further minimize area requirements as would conveyorized racks for some of the major (prime-time) forwarders. There should be little difference in productivity to use a forklift to store and retrieve cargo from the floor or from a rack. Small-piece shipments would require an additional step for transferring cargo from the rack to a hand cart. However, powered conveyors similar to those used by dry cleaners could bring the small pieces directly to the truck dock.

Vertical storage is an accomplished fact for terminating international cargo. Because dwell time of international cargo is five or more times the storage time of terminating domestic cargo, the import warehouse has been approached using classical warehousing techniques. In most of the surveyed terminals, the previously noted techniques for volume utilization have been employed. Areas for improvement include narrow-aisle technology and extended rack heights, better correlation of the shipment with storage module sizes, and integration of the ULD stacker system into import warehouse operations for large shipment storage. Greater utilization of CLCs will reduce storage requirements but will also require better rates and revisions to customs procedures and operations.

Average import cargo storage times ranged from 1/2 to 5 days, but sometimes cargo may be in storage as long as a month. If no entry has been made for an import shipment after 10 days, the shipment can be sent to a general customs warehouse. Once an entry has been filed, the shipment can remain another 5 days. On-airport storage charges are higher than at the general warehouse. If storage utilization is low, the operator may retain the shipment in the terminal import warehouse. Import storage tends to grow over the weekends when aircraft continue to arrive but businesses are not open to claim the cargo. Approximately 90 percent of all import cargo would be picked up within 2 or 3 days. On large-lot shipments, a single-piece inspection is usually all that is required unless the shipment is suspected. Customs provides an 0800 to 1630 clearance service Monday through Friday and limited overtime inspection of perishables only on Saturday. Live animals, fish, plants, dated printed material, etc., are considered perishables. Inspection service is the same regardless of shipment size, value, or type of commodity except for weekend inspection of perishables. Shipments are inspected as the paper becomes available. The depth of inspection is dependent upon commodity and paper agreement and whether the cargo originated in a high-risk area. Shipments are inspected for narcotics and revenue protection. The consignee must be present for formal entry proceedings. CLCs can be processed through the terminal system to a limited number of off-airport container stations in major cities. Major forwarders or agents provide bonded warehouse storage and customs inspection services at these stations. It was indicated that the availability of customs inspectors has limited the number and size of the off-airport container stations. In general, it was felt that customs was trying to provide service levels consistent with air cargo operations. Normal customs clearance is normally accomplished in 2 or 3 days, although personal effects may take 2 weeks or longer because consignees usually cannot make it to the site on a day's notice. Customs procedures could conceivably be streamlined in the future as experience is gained with the computer assisted processing systems presently in use at London Heathrow Airport and the Paris airports. Any change in customs procedures can have a significant impact on import cargo warehousing.

Evaluation of current terminal operations. - Cargo processing efficiency is normally related to flow-per-unit area and cost-per-unit flow. Since terminal operating cost data were either not available or highly suspect, man-hours per unit flow was substituted as a measure of efficiency. Personnel cost represents the largest single element of terminal operating cost at approximately 60 to 80 percent for conventional cargo terminal down to approximately 50 percent for a highly mechanized CLC terminal. The conventional terminals surveyed over a 5-week period at LAX, JFK, ATL, ORD, and DTW have been evaluated for productivity using airline operator data. Three far-eastern terminals were also evaluated without benefit of survey observations. Mechanization levels and CLC involvement were the basic sensitivity parameters used in the evaluation. Terminal location was not found to be of significance, although wage rates were highly disparate between domestic and far-eastern stations. Sensitivity analysis using transfer and international cargo flow levels could not be accomplished due to insufficient data. Airline participation and incomplete data also precluded detailed sensitivity analyses for the three types of carrier operations (belly pit only, combination passenger and freighter, and freighter only).

Terminal cargo flow parameters: Flow forms the basis for evaluation of any cargo processing system. Based on cargo flow data provided for 17 of the 19 surveyed domestic terminals, the mean 1976 annual cargo flow processed through the terminals was 45 500 506 kilograms. The processing levels ranged from 2 553 725 to 179 991 048 kilograms. Mean 1976 cargo flow of 20 421 651 kilograms was processed through the far-eastern terminals, while the range was from 14 640 601 to 30 218 188 kilograms. Mean 1976 cargo flow was 41 738 678 kilograms and 140 430 shipments for all evaluated terminals. Figure 3-12 shows the growth trends for the terminals using 1970, 1973, and 1976 annual flow data or close approximations thereof. It will be noted that the mean 1970 to 1973 growth rate was +18 percent per year and between 1973 to 1976 the growth rate was only 0.6 percent per year for domestic terminals. Over the indicated time span, the only collective grouping of terminals with a positive growth rate were at JFK. This shows the strong influence of international shipments.

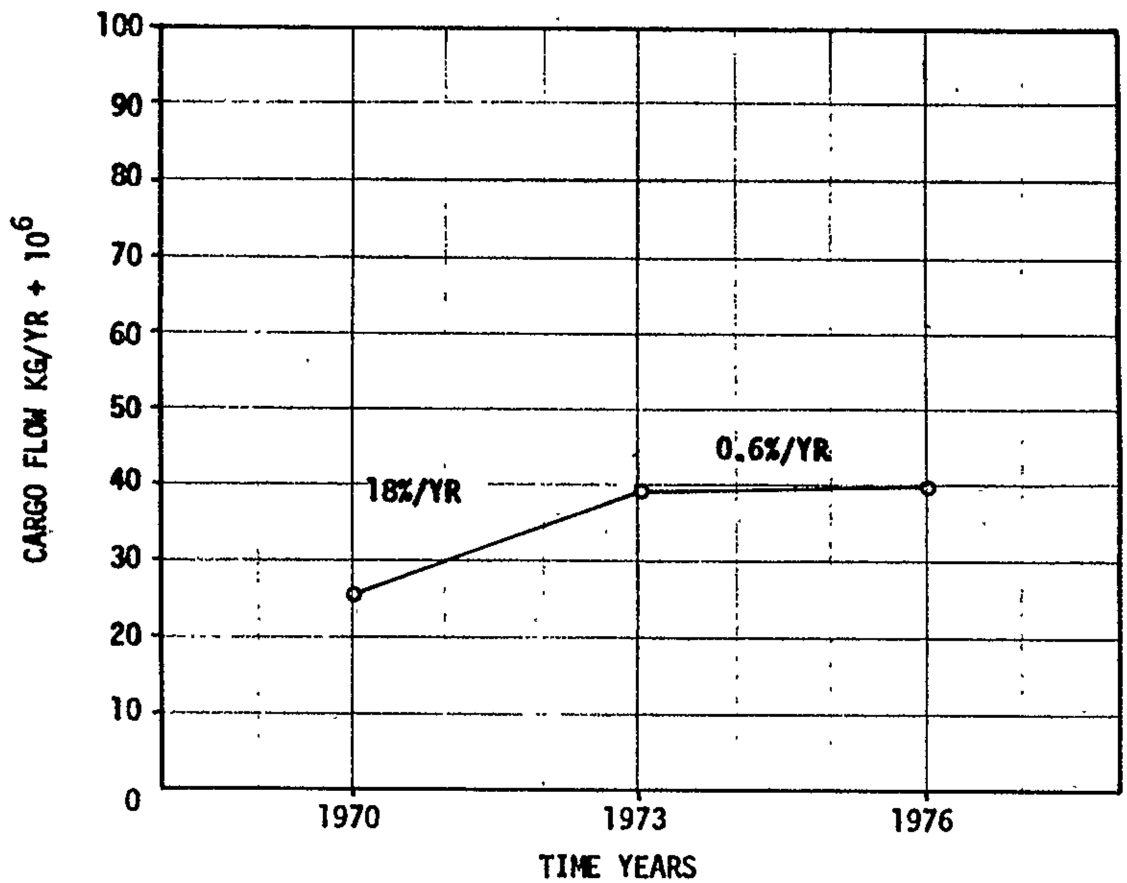

Figure 3-12. Growth Trends

Future growth at these terminals was projected to range from 5.27 to 10.09 percent. These projections are subject to unforeseen variations in business conditions, route awards, and capital availability for expansion.

Terminals that serviced only freighter aircraft experienced flow growth of from 6.12 to 288.53 percent over the last 6 years with a mean of 95.48 percent. In 1976, the mean annual cargo flow through the freighter-only terminals was 29 469 503 kilograms with a range of 2 553 725 to 61 216 373 kilograms. Cargo composition for freighter-only operations approximated 97.88 percent freight, 2.04 percent mail, 0.08 percent express, and 0.00 percent COMAT (company material) in 1976. Mean cargo shipment size was 588 kilograms with a range (mean for each terminal) from 445.4 to 1597.1 kilograms. Of the total cargo processed by these terminals in 1976, 32.2 to 78.5 percent was in CLCs for a mean of 44.2 percent. Mean size of 2120.8 kilograms was experienced with 1976 CLC shipments, and the range was 1583.9 to 3300 kilograms for the mean values at each freighter terminal.

Combination operator terminals experienced total flow growth of from -13.49 to 51.04 percent over the last 6 years with a mean of 21.07 percent. Freighter cargo processed through these terminals had a mean growth rate of 48.04 percent with a minimum of -1.30 percent and a maximum of 82.59 percent. Passenger aircraft cargo had a mean growth rate of 22.49 percent and ranged from -29.98 to 127.75 percent. In 1976, the mean annual cargo flow through combination operator terminals was 64 399 588 kilograms with a range of 12 713 726 to 179 991 048 kilograms. Mean freighter throughput was 49 887 676 kilograms with a maximum per terminal of 143 092 887 kilograms and a minimum of 11 557 197 kilograms. The 1976 mean annual cargo flow processed from 61 023 to 50 120 000 kilograms. Combination cargo terminal flow was composed of 85.27 percent freight, 9.53 percent mail, 0.20 percent express, and 5.00 percent COMAT. Mean cargo shipment size was 281.73 kilograms for total flow with freighter cargo at 322.40 kilograms and passenger aircraft cargo at 251.02 kilograms. Mean shipment weight ranged from 195.38 to 301.71 kilograms for passenger aircraft, 195.38 to 525.62 kilograms for freighter aircraft, and 176.8 to 523.1 kilograms in total. Of the total cargo processed by these terminals in 1976, 5.26 to 66.0 percent was in CLCs for a mean of 25.32 percent. Mean weight for CLC shipments was 835.39 kilograms in 1976, ranging from a minimum of 229.11 kilograms to a maximum of 1143.46 kilograms.

Terminals that serviced passenger aircraft only experienced flow growth of from -11.08 to 18.91 percent over the last 6 years with a mean of 5.30 percent. The mean 1976 annual cargo flow was 60 942 773 kilograms. with a range from 46 681 599 to 75 203 947 kilograms for the individual terminals. Cargo flow composition for passenger aircraft approximated 87.65 percent freight, 8.5 percent mail, 0.00 percent express, and 3.85 percent COMAT. Mean shipment size was approximately 200 kilograms. CLC shipments accounted for 42.16 percent of the total cargo processed by the terminals for belly-pit cargo. Minimum CLC flow was 35.12 percent and maximum was 49.20 percent with a range from 13 698 490 to 37 001 668 kilograms.

Cargo flow is variable by direction and time period. Deviation between inbound and outbound flow for the surveyed terminals in 1976 ranged from -57.79 to 63.41 percent with a mean deviation of +20.48 percent. For all terminals in the sample, the mean outbound and inbound flows approximated 18 813 450 kilograms and 44 459 shipments with minimum values at 2 239 839 kilograms and 1536 shipments and maximum values at 50 170 861 kilograms and 255 000 shipments.

The majority of the cargo terminals achieved maximum flows during the months of September, October, November, and December. The months of January, February, June, and July were normally periods of minimum flow. (Ten terminals had maximum flows during the months of September, October, and November and minimum flows during January, February, and June). The average monthly flow for all terminals was 3 797 968 kilograms and ranged from 319 216 to 14 999 254 kilograms. Maximum monthly flows ranged from 525 260 to 15 092 833 kilograms in 1976 and exhibited a mean of 4 378 781 kilograms, or 15.29 percent greater than the average. Minimum monthly flows ranged from 224 528 to 11 408 755 kilograms for all terminals in 1976 with a mean minimum flow of 2 994 539 kilograms or 21.16 percent less than the average. For individual terminals, the maximum flow deviated by -86.17 to 397.39 percent from the average and the minimum flow deviated by -94.09 to 300.39 percent from the average.

During the week, Wednesday, Thursday, and Friday were the days most often noted by the operators as peak-flow periods. Minimum-flow days were Saturday, Sunday, and Monday. Peak-flow days ranged from 421 840 kilograms and 1400 shipments down to 16 329 kilograms and 24 shipments depending upon the size of the processing operation. Minimum-flow days ranged from 229 811 kilograms and 1038 shipments down to 907 kilograms and 50 shipments during 1976. Based on a 30-day month, daily cargo flow would range from 907 to 421 840 kilograms respectively with 24 to 1400 shipments. Maximum-flow days deviated by 26.91 to -695.16 percent from typical daily flows, and minimum-flow days deviated by 49.39 to -12 515 percent from typical daily terminal flows.

Terminal operating parameters: Truck dock operations data were received for 12 terminals. Prime cargo delivery times tended to concentrate over a 5-hour period starting at approximately 2130 and completing at 0230. However, the time periods varied broadly for individual terminals based on flight departure schedules. Prime cargo delivery periods started anywhere from 1800 to 0300 and completed between 2100 to 1200 the next day. Elapsed time ranged from 1 to 12 hours. A mean of 5.6 delivery trucks per hour were offloaded at the terminals, however, the number ranged from 1.5 to 13.8 trucks per hour depending upon the particular terminal. Offload per truck approximated 1375.4 kilograms with a range from 268 to 4536 kilograms averaged at the individual terminals. Of course, hourly variations could be very pronounced.

Truck dock pickups were also found to occur over a 5-hour period, approximately 0630 to 1130. Pickup activities started between 0300 and 1000 and completed between 0600 and 1600 at individual terminals. Actual time spans ranged from 2 to 11 hours. The mean truck loading rate was 5.8 trucks per hour with a range from 1.4 to 28.6. Mean load per truck was 1514.8 kilograms with the minimum typical load at 45 kilograms and the maximum load at 5543 kilograms. Prime cargo pickup times tend to follow flight arrival patterns particularly for domestic freighter operations.

Cargo dwell times varied by flow direction and type of operation. Originating domestic cargo typically spent between 1 and 12 hours in the cargo terminal between receipt and aircraft onload operations with a mean of 4.5 hours. International originating cargo spent between 4 and 12 hours awaiting aircraft loading on the average with a mean of 8 hours. Domestic terminating cargo storage times from aircraft offload to pickup typically ranged from 1 to 12 hours with a mean of 5.1 hours. International terminating cargo storage was determined to have 52 hours mean dwell time with a range from 8 to 120 hours. Transfer cargo storage time between offload and onload operations ranged from 1 to 8 hours with a mean of 5.5 hours. Times for CLC operations would tend to be minimal.

Buildup and breakdown activities overlap with truck dock operations and cargo storage times. In larger terminals, buildup and breakdown activities also overlap with freighter offload and onload activities since multiple arrivals and departures are involved. The time span for buildup and breakdown activities is extended for terminals servicing a large number of freighter aircraft. Similarly, the time span is longer when multiple passenger aircraft operations are involved. Load buildup activities for freighter aircraft tended to occur over a 6-hour period from 2130 to 0330. The noted time periods ranged from 1 to 11 hours, starting times ranged from 1800 to 0600 the next morning, and completion times ranged from 2200 to 0900 the next day. Based on standard freighter pallets (224 x 318 centimeters), approximately 2.2 equivalent ULDs were built up per hour of the buildup period with a minimum of 0.8 and a maximum of 4.3 ULDs per hour. Load buildup activities for passenger aircraft cargo ranged from 4 to 16 hours with a mean of nearly 8 hours. Buildup activities started anywhere from 0400 to 2300 and completed anywhere from 1200 to 0200.

Freighter load breakdown operations were conducted over a mean 5.5-hour period with a typical range from 3 to 11 hours at the individual terminals. Breakdown activities started between 2200 and 0700 with a mean time of 0330 hours. Freighter breakdown activities were completed between 0500 and 1530 with the mean time at 0900 hours. During this period, 2.6 standard freighter

ULD loads were broken down per hour with a typical range from 1.0 to 9.5 units per hour. Load breakdown activities for passenger aircraft cargo ranged from 1.5 to 8 hours with a mean time of 5 hours. Breakdown activities started anywhere from 0400 to 1730 and completed between 0800 and 1990.

Cargo terminal area was defined for analytical purposes to include the complete terminal floor area, office area, maintenance area, and aircraft ramp area used for cargo processing (buildup, breakdown, storage, and staging functions). Terminal area ranged from a low of 557 square meters to a maximum of 14 736 square meters. The mean terminal area was 5210 square meters. The largest single increment of cargo terminal area was used for buildup and breakdown operations. Buildup/breakdown terminal areas ranged from 167 to 3670 square meters representing 12.84 to 24.90 percent of the terminal area. The average buildup/breakdown area of 1110 square meters represents 19.96 percent of the average terminal area, 5560 square meters. Expansion or maximum use of buildup/breakdown area is important to flow and sensitive to peak shipment delivery, staging, and storage of shipments. Maximum utilization by cube or weight of ULDs requires selectivity of cargo for buildup. For maximum utilization of area, buildup was begun as soon as base freight arrived. Terminating storage area is the next largest utilized block area ranging from 56 to 3716 square meters and comprising from 4.30 to 68.97 percent of the terminal area. The average terminal terminating storage area was 1223 square meters, comprising 22.01 percent of the average terminal area. This area is needed because of the long inbound storage time. The average total terminal land area was 28 917 square meters with the maximum and minimum areas being 79 430 and 1446 square meters respectively. The average aircraft ramp area, 16 460 square meters, represents 56.92 percent of the average total terminal area. Individual ramp areas ranged from 2787 to 41 190 square meters and represented 14.42 to 51.86 percent of their total terminal areas.

Total personnel levels associated with the terminals under study ranged from 11 to 729. Mean manpower was 169 men, and mean man-hours worked per month was 26 577. A typical range of man-hours per month ranged from a minimum of 1903 to a maximum of 105 237. Management and administration typically accounted for 6.73 percent of the total. Direct supervision accounted for 8.21 percent, warehousemen accounted for 23.16 percent, and ramp handling personnel accounted for 46.63 percent; the remainder is composed of agents, reservationists, and sales. Further functional breakdown was impossible since personnel performed a variety of tasks as the demands on the terminal changed during the day.

For the airlines operating only passenger aircraft or passenger aircraft in combination with freighters, definition of ramp operations was obtained for those passenger flights which were major factors in the distribution of air cargo. Offload and onload activities for these passenger flights were scheduled for 1.5 to 2.5 hours on the passenger terminal ramp with a mean elapsed time of 2.00 hours. Between 0.54 and 8.82 passenger aircraft with strong cargo orientation were handled per hour during this period with a mean of 2.67. Wide-body passenger aircraft were scheduled on the ramp for 2.5 hours. These cargo-oriented passenger aircraft ramp operations generally occurred between 0700 and 2100. Average cargo offloads ranged from 1696 to 11 884 kilograms (5141 kilograms mean) for wide-body aircraft. Average cargo offloads on narrow-body passenger aircraft had a mean of 1773 kilograms and ranged from 1667 to 1880 kilograms. Maximum and minimum typical cargo onload for wide-body passenger aircraft were, respectively, 1941 and 11 002 kilograms with a mean of 4994 kilograms. Average cargo onload for narrow-body passenger aircraft ranged from 1667 to 2857 kilograms with a mean of 2262 kilograms. From 31 to 104 narrow-body passenger aircraft and from 7 to 84 wide-body passenger aircraft interfaced with the cargo terminal each week. The mean number of passenger aircraft serviced with an impact on the cargo-processing operations were 246.2 narrow-body and 105.2 wide-body. Between 4 and 129 of these narrow-body passenger aircraft and 1 to 21.0 of these wide-body passenger aircraft were serviced daily.

Aircraft ramp operations were generally conducted at different times for passenger and freighter aircraft. Freighter offload and onload activities were scheduled for 1.25 to 9 hours on the ramp with a mean elapsed time of 2.05 hours. Between 0.11 and 1 freighter per hour were handled during this period with a mean of 0.54 freighter per hour. B747 freighters were scheduled on the ramp for 3.11 hours on the average while narrow-body freighters were scheduled for 1.67 hours. Freighter offload operations were normally scheduled to start from 1700 to 0600, and onload was scheduled for completion from 2200 to 0700. However, off-hour operations and international flights tend to extend the time ranges over the prime domestic freighter operating times by 2 hours. Domestic offload/onload operations were normally scheduled from 2200 to 0600. Average freighter offloads ranged from 6804 to 23 868 kilograms, or a mean of 14 557 kilograms, for narrow-body aircraft. The mean offload was 21 175 kilograms for B747 freighters with a range from 13 779 to 28 571 kilograms. Mean onload weights for narrow-body and B747 freighter aircraft were, respectively, 17 217 and 21 950 kilograms. Minimum typical onload for the B747 freighter was 11 570 kilograms, and the maximum was 32 331 kilograms. The typical onload range for narrow-body freighters was 8014 to 25 657 kilograms. One should note that onloads and offloads do not represent total aircraft loads because of multiple station routing on certain flights. The cargo terminals serviced from 5 to 149 narrow-body freighters per week and from 1 to 26 B747 freighters per week. Stations with narrow-body service only processed a mean of 34.71 freighters per week. Stations handling both freighter types serviced a mean of 115.50 narrow-body freighters and 13.50 B747 freighters each week. Between 1 and 14 narrow-body freighters were handled per day at the terminals. Daily B747 freighter operations ranged from one to four at the surveyed terminals.

Cargo processing productivity: Operations at a cargo terminal are affected by flow direction and characteristics, air and surface transport vehicle scheduling, facility and equipment capabilities, personnel performance and costs, plus governmental constraints. Many of these parameters require extensive analysis to establish the impact on the processing system and will be quite variable from system to system. Analyses contained herein were designed to provide an overall understanding of terminal performance.

The amount of cargo processed through a given terminal area is the most basic evaluation and planning tool. It is of primary interest for gross allocation of airport land areas to accomplish given throughputs. Figure 3-13 displays the cargo weight flow per month and corresponding terminal areas from

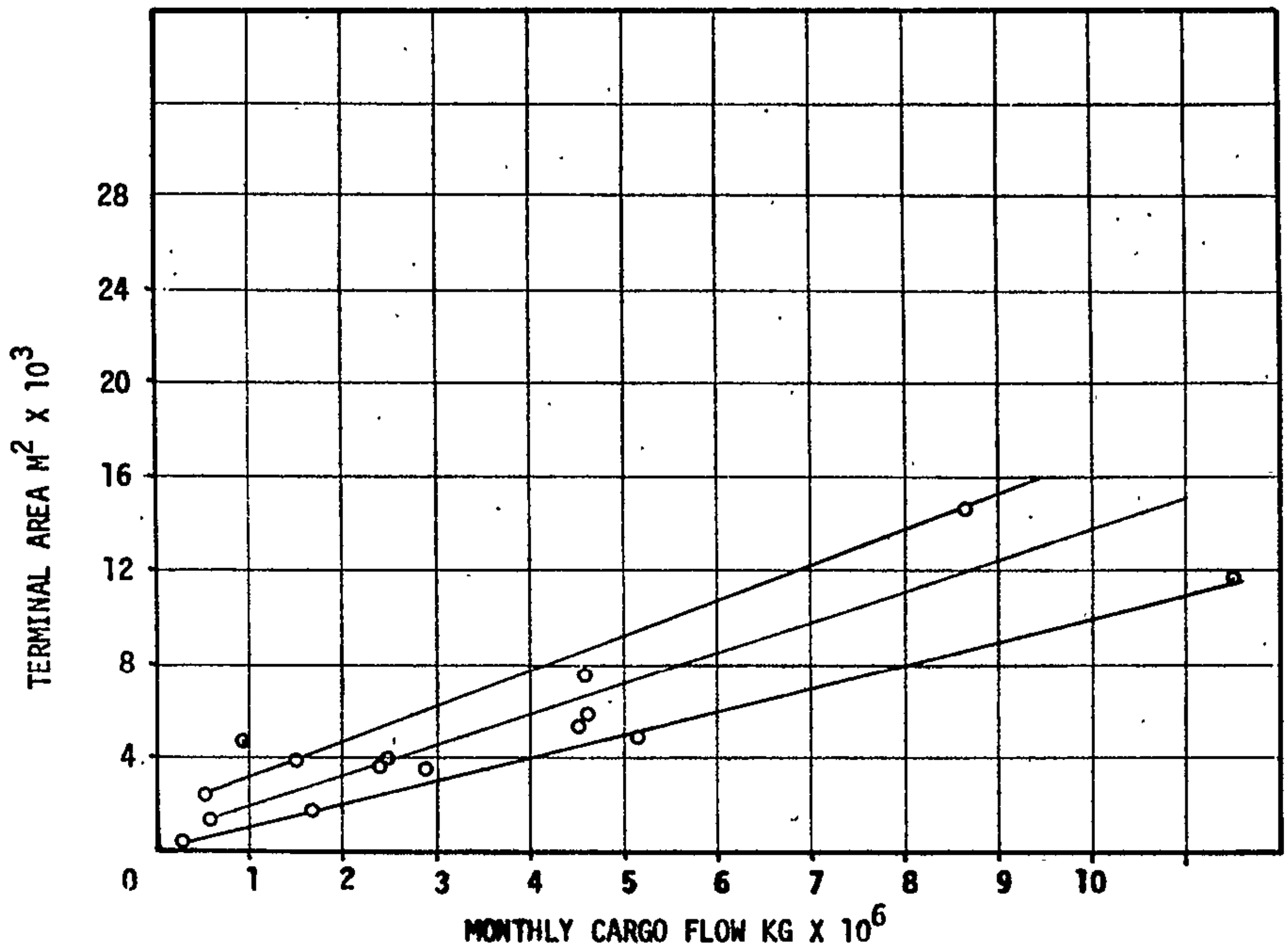

Figure 3-13. Terminal Cargo Flow

the surveyed airline stations. The trend line established through statistical analysis provides a basic summary of the flow versus area parameters for 15 terminals in the current air cargo system. The rather well-defined upper and lower boundaries are perhaps of greater interest. For nearly equal terminal areas, processed cargo flow was found to exhibit wide variations and vice versa. Operations along the lower boundary reflect more efficient utilization of the terminal area. These operations were composed of terminals which were nearing their capacity limits and/or were composed of domestic freighter terminals. The terminals along the upper boundary were composed of operations highly involved with international cargo processing and/or operations which are immature. Within limits, growth potential can be easily estimated for the terminals by extrapolating the current operating point at constant area to some flow level between the trend and lower boundary lines. In certain cases, the lower boundary could even be exceeded through installation of equipment capable of using terminal volume more efficiently, through revision in transport scheduling, through revision in flow conditions, and through variations in other parameters. However, detailed analyses are required to establish and evaluate these limits.

Review of the questionnaire data showed that a mean of 8.37 hours was required to process 1000 kilograms of cargo at 13 surveyed terminals. The range extended from 3.08 to 14.75 hours per 1000 kilograms. Figure 3-14 illustrates that as processed cargo flow increases, the hours required to process a unit of cargo tends to decrease. The trend produced by economy of scale is expected since smaller operations have a very difficult time balancing manpower. Manpower must be low during slow periods, yet adequate to provide efficient service during peak periods. Part-time help is often prohibited or curtailed by union regulations. For a given flow level, Figure 3-15 shows a broad range in hours worked per 1000 kilograms of cargo. All points along the upper boundary represent terminals with strong international and/or combination cargo operations. Domestic all-freighter operations tend to concentrate along the lower boundary, although there are several terminals in that region which also have strong international cargo involvement. Two of the

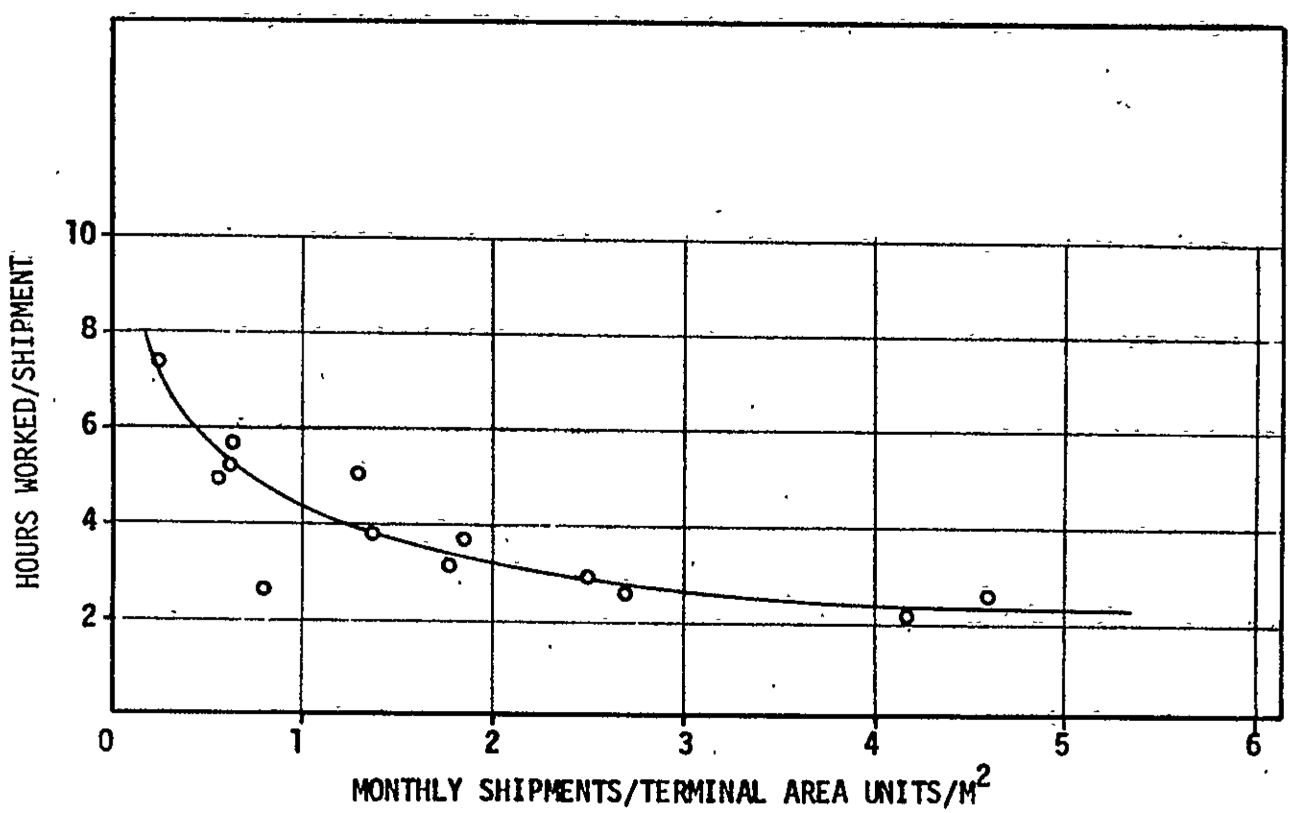

Figure 3-14. Economic Comparison of Terminal Flow

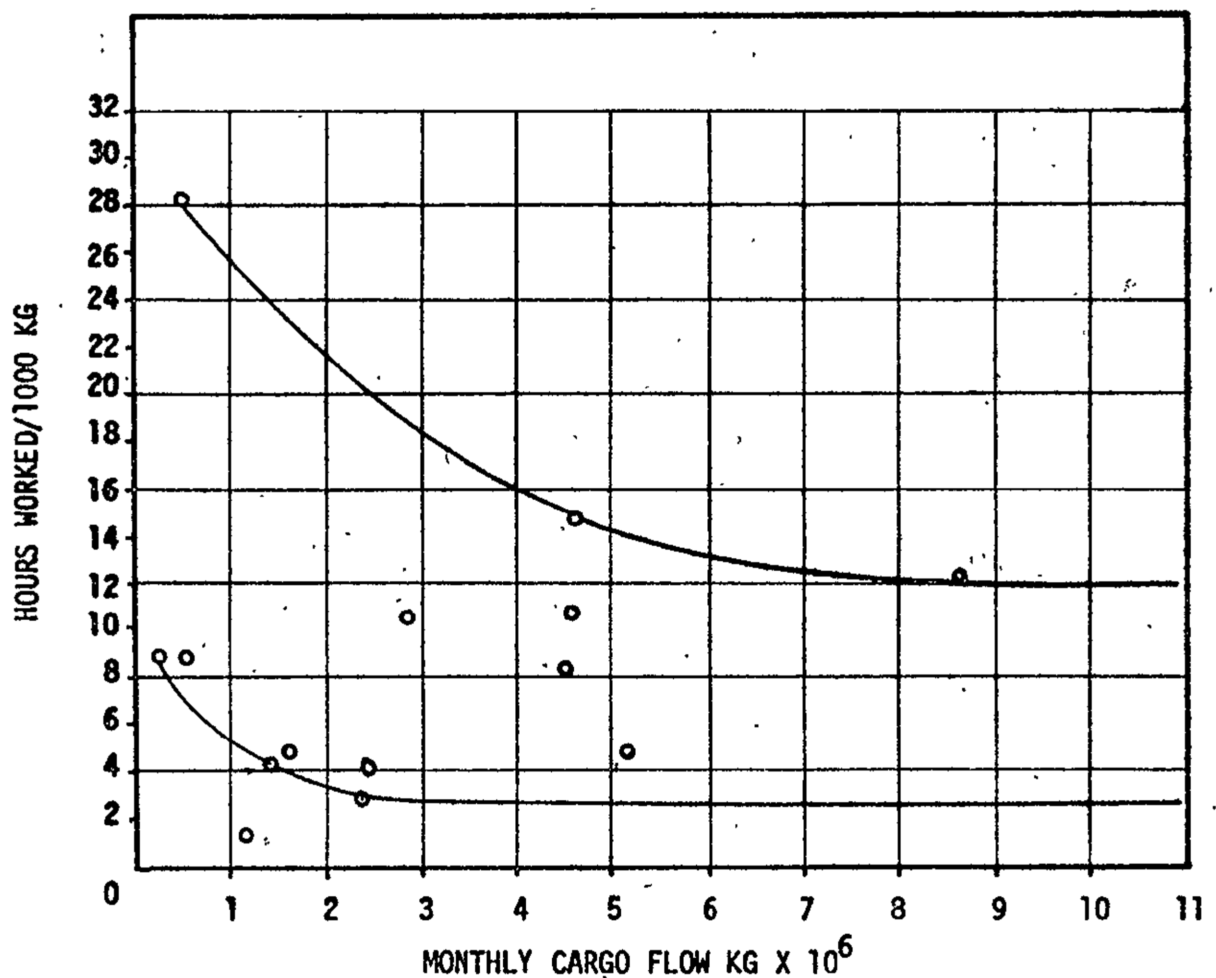

Figure 3-15. Monthly Cargo Flow Variations

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three far-east terminal operations are located close to the lower boundary. Work rules and work incentives at those terminals may form the basis for their relatively good productivity. Two U.S. terminals with strong international cargo operations are also located along the boundary and process cargo at approximately 5 man-hours per 1000 kilograms. Hence, it is very difficult to categorize productivity by flow level or type of operation.

Cargo flow can be considered in terms of weight, volume, and units (pieces and shipments). While volume is one of the most useful parameters, it is generally unavailable for commercial cargo operations unless extensive cargo characteristics surveys have been conducted. These data must be capable of being correlated to some basic flow parameter. Weight is the basic flow parameter but often does not tell the complete story. Shipment and piece flows provide a different perspective on processing operations.

Figure 3-14 provides a productivity summary in terms of hours per cargo flow unit and cargo flow per terminal area. In this case, shipments have been employed as the flow parameter. Ideally, the most efficient terminal is one which minimizes both terminal area and operating cost (primarily manpower) for a given flow. Hence, those stations which are on the lower-center to right-hand portions of the trend curve in Figure 3-14 are considered to be processing shipments very efficiently. Three of the six points on this portion of the curve were along the upper boundary curves in Figures 3-13 and 3-15. Stations which were along the lower boundary curves in the previous two figures are on the upper left-hand portion of the trend curve in Figure 3-14. These differences result from the weight of the shipments typically processed at these stations. The stations on the right-hand portion of the Figure 3-15 trend curve are primarily for combination operations. Extensive Douglas cargo characteristics studies (Reference 3-1) showed that cargo carried on U.S. passenger aircraft was smaller than cargo carried on U.S. freighter aircraft. Shipments were 33 percent smaller in volume and weight, 60 percent fewer pieces composed the shipment, and piece volume and weight were also approximately 60 percent smaller. Hence, combination operator terminals will not be as productive in terms of weight-processing capability as all-freighter operators.

These conclusions are reinforced by Figure 3-16. Weight flow has been substituted for shipment flow. The trend line for cargo terminals servicing a combination of passenger and freighter aircraft is significantly higher than the trend line for terminals servicing only freighter aircraft. While the individual data points are quite scattered, descriptive statistical analysis was used to establish the trend lines from the limited data sample. The trend lines provide a reasonable approximation of productivity for combination and freighter terminal operations using weight flow in Figure 3-16 and shipment flow in Figure 3-14.

CLC impact on productivity: Movement of goods in containers directly between the consignor and consignee provides potential benefits to all parties. CLC cargo flow significantly reduces handling operations in the terminals but does require capital investment for all system elements. The investment burden is less on the consignee and consignor with forkliftable submodules such as the Type D container or small aircraft containers such as forkliftable LD-3 containers. On the other extreme is the AS-832 family of large aircraft containers with 2.4- x 2.4-meter cross sections and lengths ranging from 3 to 12.2 meters in length. Because of their end-loading capability, they can be loaded on their chassis at any standard truck dock.

Cargo in CLCs accounted for up to 78.5 percent of the weight flow and up to 38.0 percent of the shipment flow at 16 of 19 surveyed terminals which provided data. Overall, CLC cargo accounted for 39.2 percent of the total weight flow and 11.3 percent of the total shipment flow. Combination operations had CLC flow which accounted for 5.3 to 50.0 percent of the weight flow and 0.9 to 10.4 percent of the shipment flow. Mean CLC flow through combination terminals was 36.2 percent by weight and 10.4 percent by shipments. For freighter operations only, the mean CLC flow was 48.9 percent of the weight flow and 13.9 percent of the shipment flow. The range of CLC penetration at freighter-only terminals was from 14.0 to 78.5 percent by weight and from 4.0 to 10.3 percent by shipment flow. CLC operations for international cargo movement is considerably lower than for domestic operations due to the rating structure. While international CLC movement is estimated to be about 20 to 25 percent by weight of the total flow, a precise level could not be

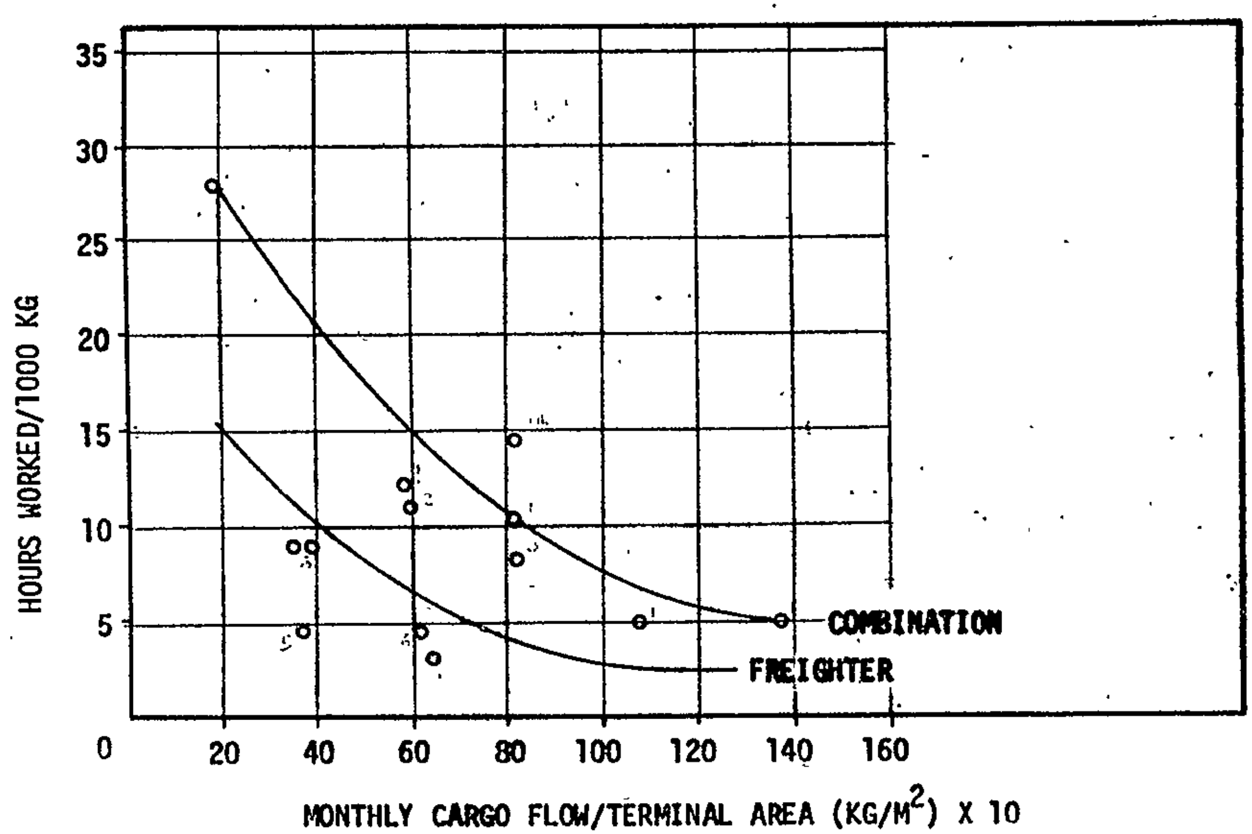

Figure 3-16. Terminal Productivity

established from the available data. Domestic CLC movement is estimated to be about 50 percent of the total flow particularly for prime-time freighter operations.

There appears to be some correlation between CLC flow and terminal size. When the graph of cargo flow versus terminal area was analyzed, the operating points broke down into two major sectors. In Figure 3-17, terminals processing less than 4 million kilograms per month had between 30 and 80 percent CLC flow for 5 of 6 stations. CLC flow was not identified for the other two stations. Terminals processing between 4 and 15 million kilograms per month had between 10 and 50 percent CLC flow. The larger terminals in this region showed a mixed trend with one station at 10-percent CLC flow and the second at 50-percent CLC flow. Both were combination terminals with variations in international involvement. However, between 4 and 6 million kilograms per month, CLC flow for the four stations ranged between 20 and 48 percent. Three of these four stations had CLC flow between 35 and 48 percent. It is difficult to establish definite correlation between terminal area, total flow, and CLC flow because of the variations in system maturity, type of operation, and scheduling. From Figure 3-17, it may be concluded that the degree of CLC involvement for the small- to medium-sized terminals was a prime factor in establishing the slope of the curve. Greater area would be required to process a given total flow with lower CLC involvement.

As the weight flow in CLCs increased for the surveyed terminals, the total weight flow processed per terminal area also reflected an increase as illustrated in Figure 3-18. This trend was reasonable since the terminals could process the larger loads without the area-intensive storage and staging operations required for bulk cargo. Following this line of reasoning, man-hours per unit weight of cargo should also show a reduction as CLC cargo flow increases. The station operating points used to establish man-hours per 1000 kilograms of cargo as a function of monthly cargo flow per terminal were found to provide three distinct regions of CLC involvement. From Figure 3-19, the highest region of hours-per-weight flow corresponded to a CLC flow range of 0 to 20 percent and to terminals servicing both passenger and freighter

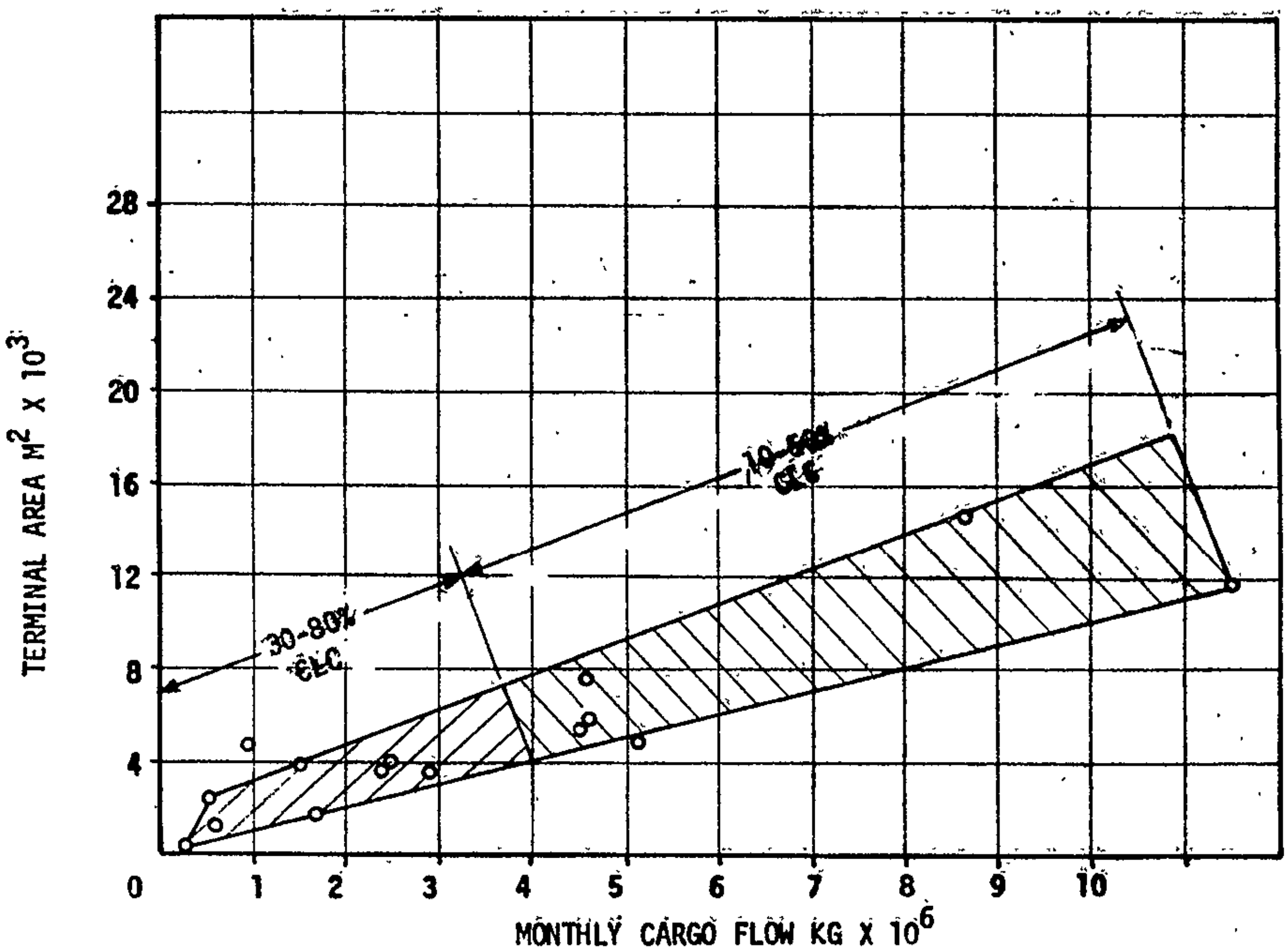

Figure 3-17. Monthly Cargo Flow per Terminal Area (CLC)

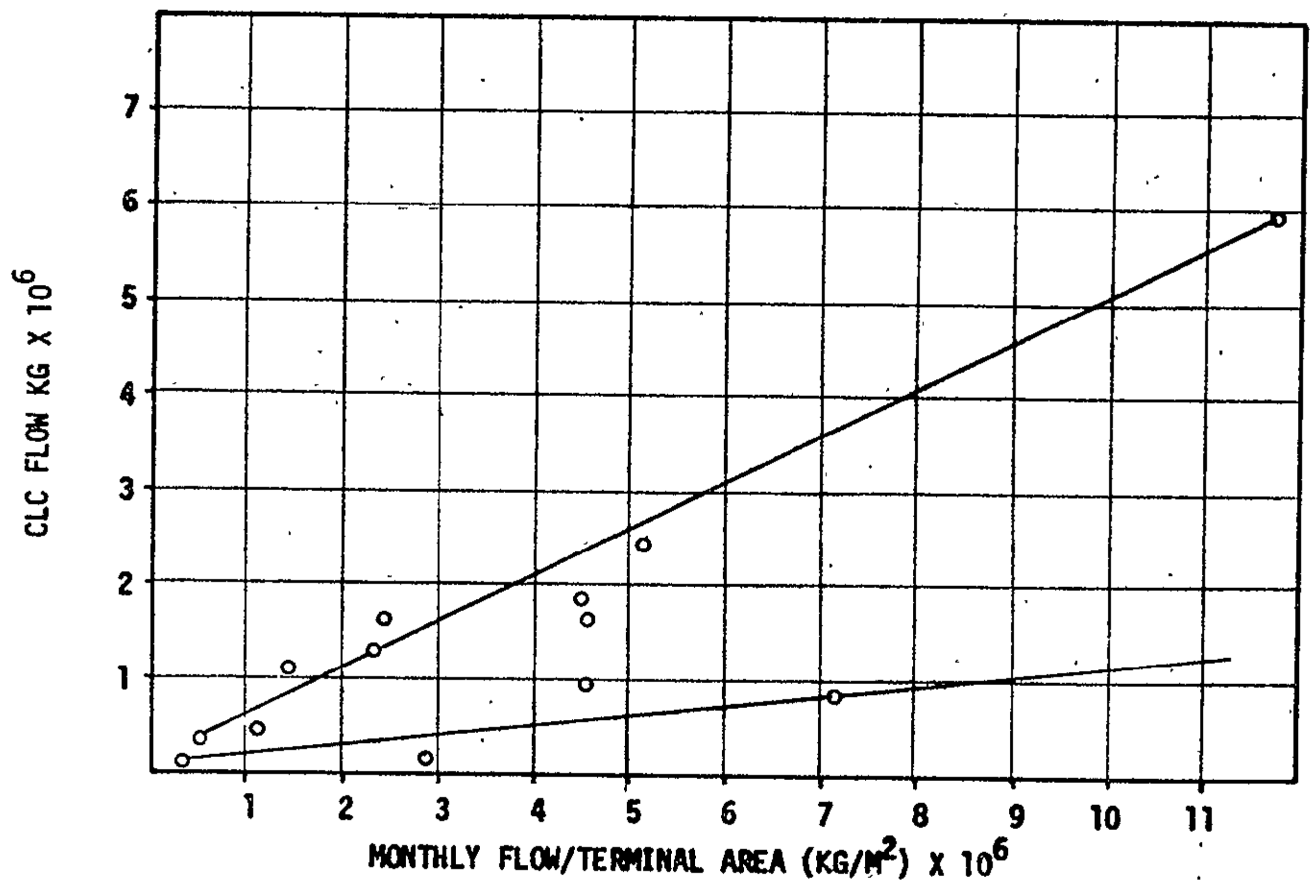

Figure 3-18. Shipper-Loaded Container Flow

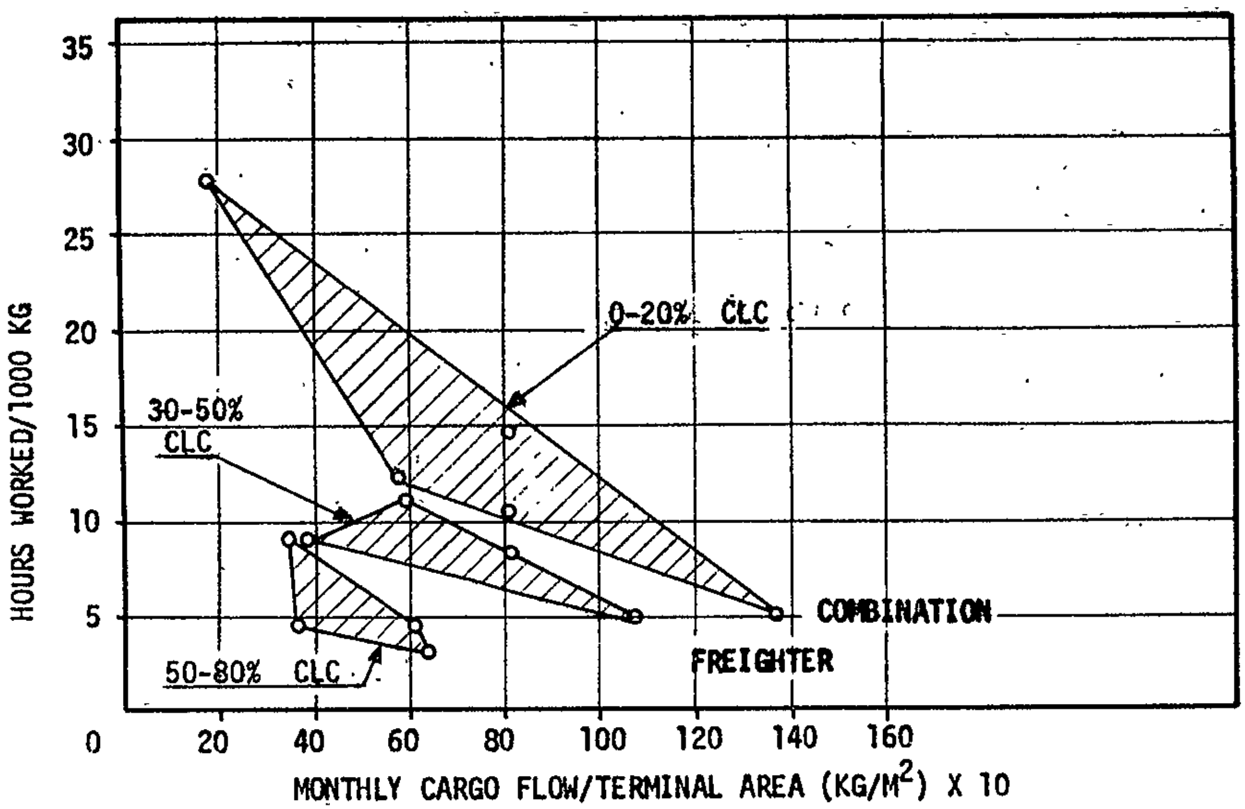

Figure 3-19. CLC Terminal Involvement

aircraft. The midregion involved CLC flow from 30 to 50 percent. The lowest region of hours per 1000 kilograms of total flow corresponded to a CLC flow range of 50 to 80 percent. If flow per terminal area is held constant, for example, at 600 kilogram/square meter, man-hours per 1000 kilograms are appoximately 16 for 0-20 percent CLC flow, 10 for 30-50 percent CLC flow, and 4 for 50-80 percent CLC flow. Medium and high levels of CLC flow, respectively, help achieve manpower productivity gains of 37.5 and 75.0 percent over operations with low CLC flow. Between high and low CLC flow ranges, the cargo processed per unit terminal area must be increased by approximately 3.5 times to achieve the same level of personnel productivity. These regions are far from complete due to limited data, but the trend appears to be well established.

A similar analysis was conducted for CLC shipment flow. When monthly man-hours per shipment were studied as a function of monthly shipments per terminal area, CLC shipment flow was found to segregate into two regions. As noted in Figure 3-20, CLC shipment flow of 20 to 40 percent occurred at four operations below one shipment per terminal unit area. CLC shipment flow from 0 to 20 percent was found to exist over the range from one to five monthly shipments per terminal area. One would expect shipments per unit area to decrease as CLC flow increased. Man-hours per shipment could also be expected to remain the same, or show a modest increase, as CLC flow increased. Man-hours per shipment would decrease with an increase in CLC flow only if CLC handling was highly mechanized.

System mechanization and productivity: Freighter main deck offload and onload operations were documented at nearly all surveyed stations to establish the relative merits of fixed-dock and mobile systems. Delays which were beyond the scope of the loading system were excluded from the man-hours expended during the offload and onload cycles. Delays due to improperly maintained equipment or system deficiencies were maintained within the cycle. No significant deviations in productivity were determined for the two narrow-body freighter handling systems. Mobile systems processed a mean of 4.5 pallets per man-hour with the minimum at 2.7 and the maximum at 7.2 pallets per man-hour. A deviation of approximately 1.5 pallets per man-hour was observed between well-maintained and poorly maintained or equipped systems. Fixed-dock

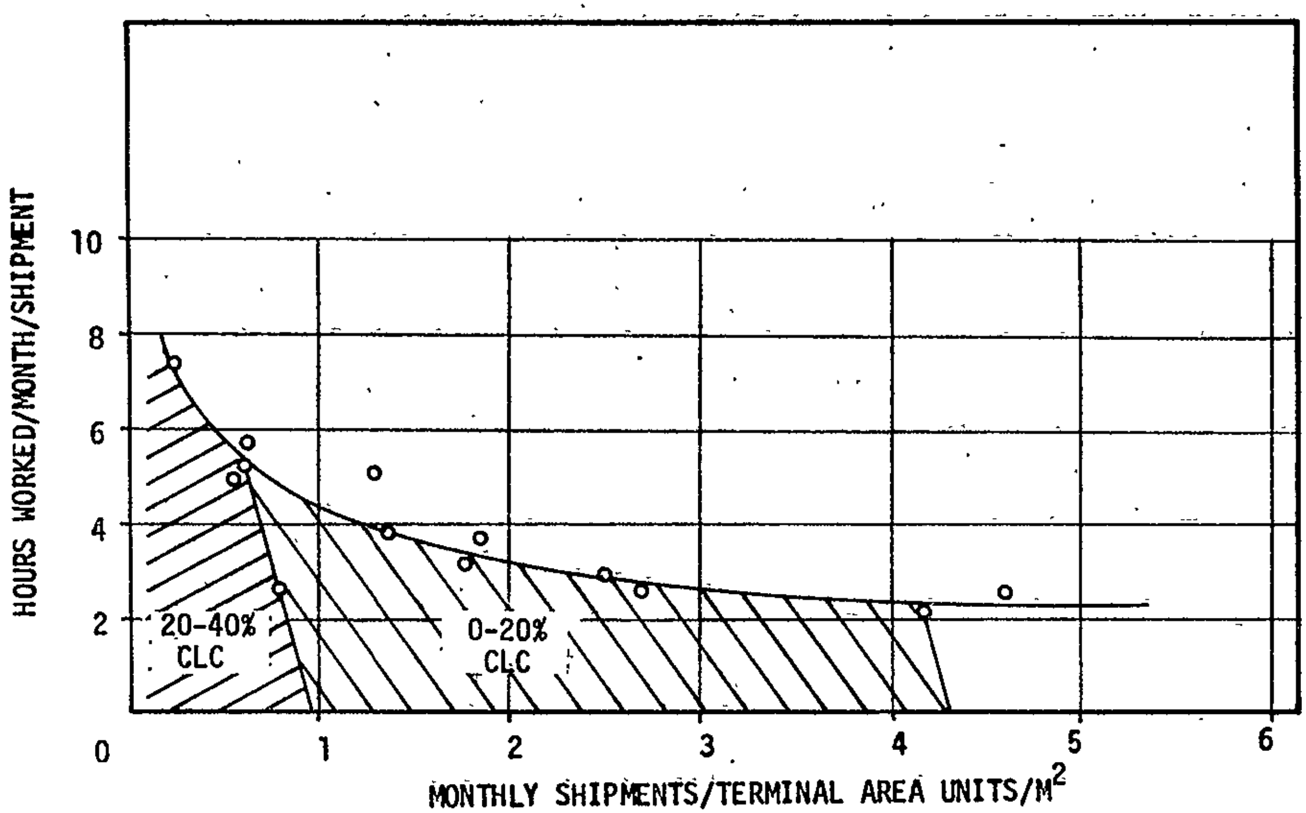

Figure 3-20. CLC Shipment Flow Involvement

systems processed a mean of 4.4 pallets per man-hour with the range from 3.3 to 9.0 pallets per man-hour.

Certain narrow-body freighter aircraft were equipped with powered main-deck handling systems. While these systems provided no advantage in speed over the manual handling systems, manpower was reduced by approximately two men. Hence, productivity with powered aircraft-handling systems ranged from 4.9 up to 15.2 pallets per man-hour with a mean of 6.8 pallets per man-hour. The productivity increase was nearly 55 percent more than with comparable manual system.

All B747 freighter main-deck operations used mobile ramp equipment with powered loading systems on the main deck. Productivity ranged from 3.6 to 5.7 pallets per man-hour with a mean of 4.3 pallets per man-hour. The powered main-deck system was slightly less productive than the narrow-body manual systems. This was caused by longer loader cycle times due to increase elevation of the main deck from the ground. Also, larger ULD loads on the B747 freighters had a slightly greater tendency towards hangups, and only the two man crew on the main deck was available to free them. Large ULDs were counted as two equivalent aircraft pallets.

Study constraints precluded evaulation of passenger aircraft lower-deck operations. However, a study of this nature was conducted for a major airline at four stations during 1974-75 by nearly the same Douglas Aircraft Company team. A total of 73 offload and/or onload operations were documented. Off-load and onload of baggage, mail, and freight produced gross productivities of 129 pound/man-minute on wide-body aircraft and 61 pound/man-minute on bulk loaded narrow-body aircraft. Productivities for mail and freight handling on wide-body aircraft were 152 and 219 pound/man-minute respectively. On bulk-loaded aircraft, mail-handling productivity was 69 pound/man-minute and freight-handling productivity was 76 pound/man-minute. The powered loading systems and ULDs used on wide-body passenger aircraft produced productivities 2.1 times greater than comparable handling of baggage, mail, and freight with bulk-loaded narrow-body passenger aircraft. For mail only, the productivity was 2.2 times greater;and for freight only, the productivity was 2.9 times greater for wide-body passenger aircraft over bulk-loaded passenger aircraft.

To provide a rough comparison between freighter and passenger aircraft operations, mean net pallet (and container) weight was established at 1564 kilograms for freighter aircraft from previous Douglas studies (Reference 3-1). Productivity for freighter aircraft appoximated 4.4 pallets/man-hour for all operations except narrow-body freighters with powered main-deck systems which were at 6.8 pallets/man-hour. These productivity levels were respectively comparable to 253 and 391 pound/man-minute. Excluding the time and manpower to transport freight to the passenger terminal, freighter aircraft ramp operations productivities showed 15.5 and 78.5 percent increases over wide-body passenger aircraft freight-handling operations and 232.9 and 414.5 percent increases over bulk-loaded narrow-body passenger aircraft freight handling. Freighter aircraft will inherently have higher productivity than lower-deck operations on wide-body passenger aircraft because of the capacity of the ULDs. Similarly, if a B747 operator is maximizing volume utilization in the center and aft sections of the main deck, productivity will be greater because of the larger module loads. Cargo density and ULD loading efficiency also impact productivity when weight is used as a measure. Weight is essential when a comparison is made of bulk and unitized loads.

Very detailed analyses would be required to precisely relate mechanization of terminal systems to cargo-processing productivity. To provide a gross relationship between mechanization and processing productivity, a mechanization index was established for major processing functions prior to conducting the terminal surveys. A total of 24 points comprised the mechanization index with 3 points allocated to airbill processing and control, 4 points allocated to both inbound and outbound pallet handling and storage, 3 points each assigned to inbound and outbound bulk cargo storage, 3 points allotted to bulk-cargo sortation, and 2 points each to inbound and outbound bulk-cargo handling. The highest index achieved by a surveyed terminal was 17 points, or nearly 71 percent of the total. The lowest index was 9 points, or 37.5 percent of the total points. The mean index was 13.6 points for the 19 surveyed terminals. Airbill processing averaged 1.9 points, inbound pallet handling averaged 2.9 points, outbound pallet handling averaged 3.3 points, inbound bulk cargo storage averaged 1.3 points, outbound bulk cargo storage averaged 1.2 points, and all other functions averaged 1.0 point. Pallet handling and airbill processing have received the most attention towards mechanization essentially because standardized units and data are involved. Further, mechanized pallet handling permits more effective use of terminal area.

Terminals with low monthly cargo flow and small areas also exhibited the lowest mechanization index. This point is illustrated on Figure 3-21 where terminals processing below 2.5 million kilograms per month have mechanization indexes ranging between 9 and 11 points. These terminals were also the most heavily committed to CLC operations on domestic freighter routes. The mechanization index increased from 14 to 17 as cargo flow increased on the subject figure. As the level of mechanization increases, there is a tendency to process more cargo per terminal floor area. Figure 3-22 shows a slight upward trend when mechanization index is plotted as a function of kilograms per square meter. However, the bandwidth is quite broad. When mechanization index is plotted as a function of shipments per square meter as in Figure 3-23, the same upward trend is evident. Here again the bandwidth is also quite broad. This shows as the level of mechanization increases the shipments processed also increases.

As mechanization increases there appears to be a tendency for man-hours per unit flow to become more standardized. On Figure 3-24, the range of man-hours per 1000 kilograms converges as the mechanization index increases. Man-hours per 1000 kilograms range from 4 to 28 at an index of 12, but only range from 6 to 12 at an index of 17. Terminal operations along the upper boundary were generally processing low to medium CLC flows, while terminals along the lower boundary were generally processing medium to high CLC flows. A similar convergence is noted in Figure 3-25 where hours per shipment are plotted against mechanization index, and man-hours per shipment range from 2.5 to 7.5 at an index of 12, but only range from 3 to 5 at an index of 18.

The convergence of processing hours is also seen in Figure 3-26 where mechanization index ranges have been overlayed on the plot of monthly cargo

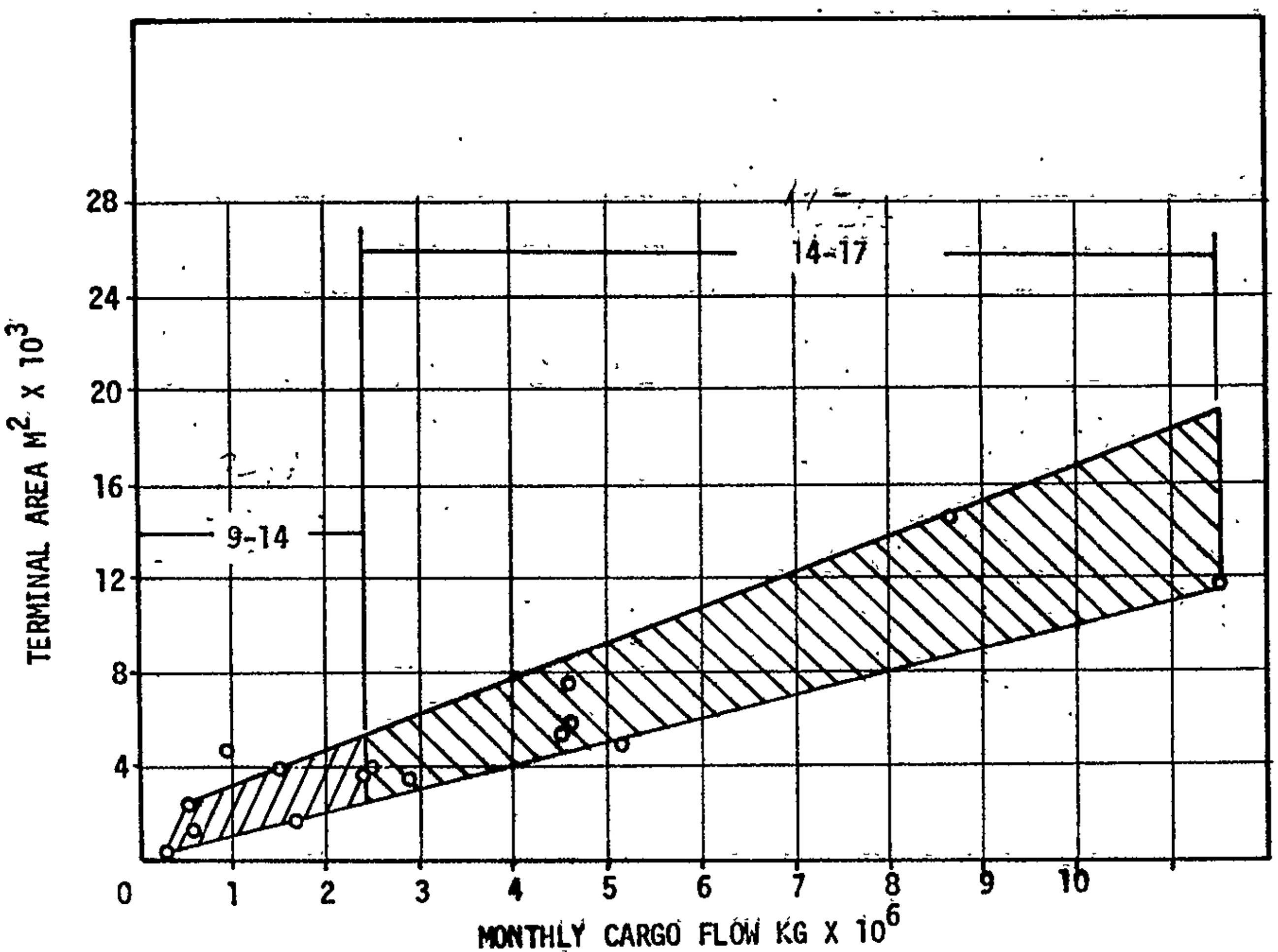

Figure 3-21. Monthly Cargo Flow per Terminal Area (Mechanization)

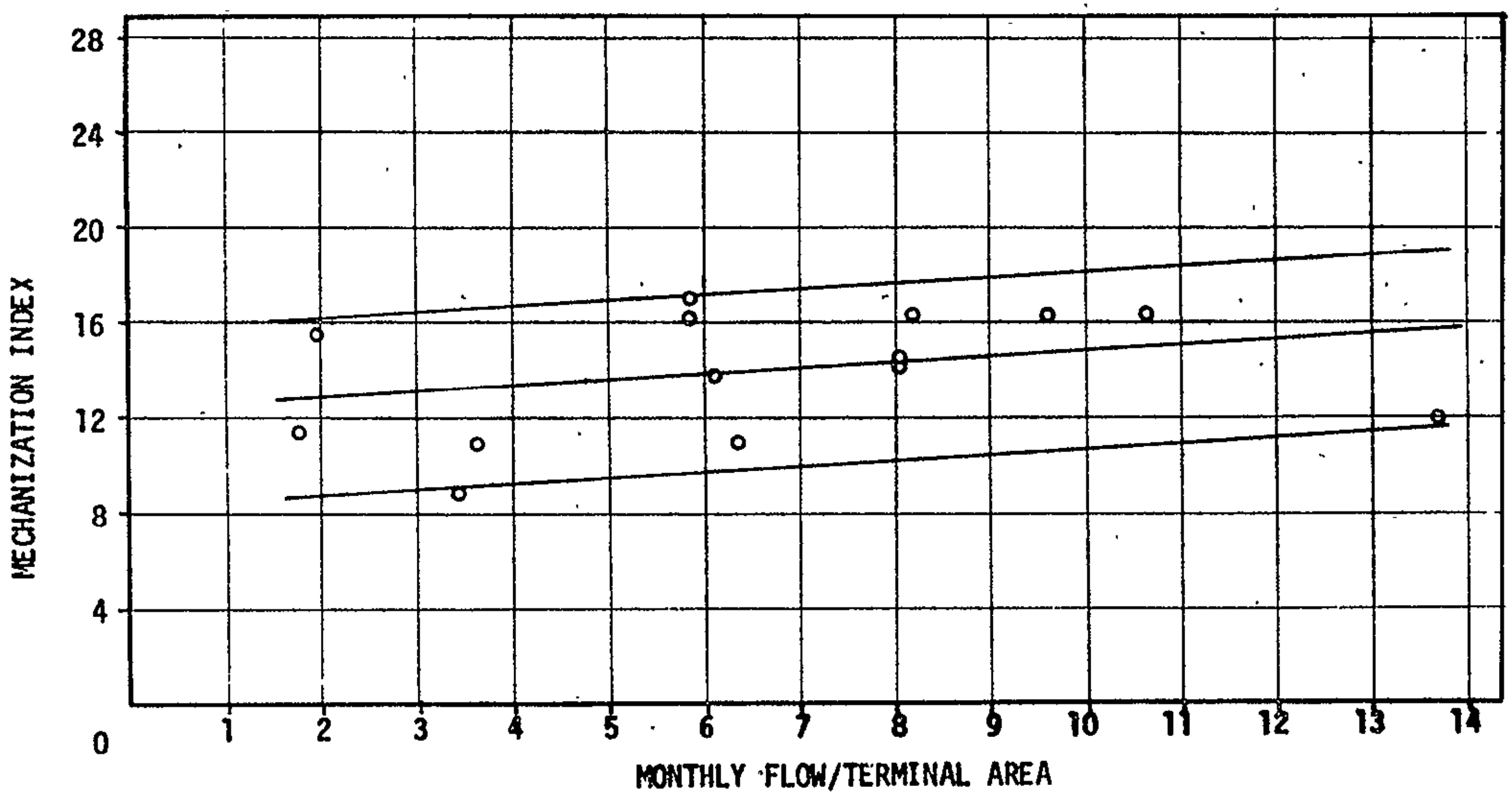

Figure 3-22. Effect of Mechanization on Monthly Flow per Terminal

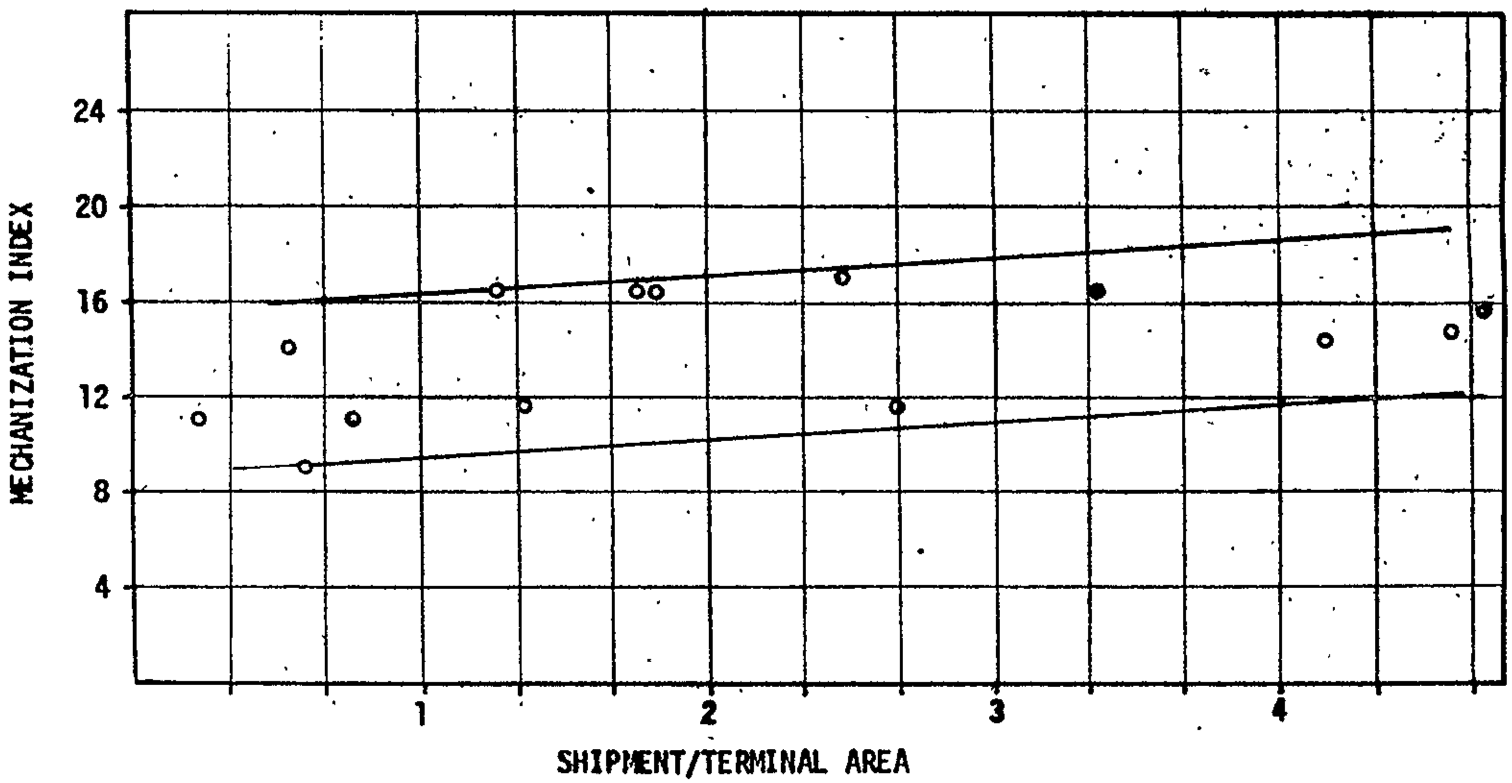

Figure 3-23. Effect of Mechanization on Shipment Flow

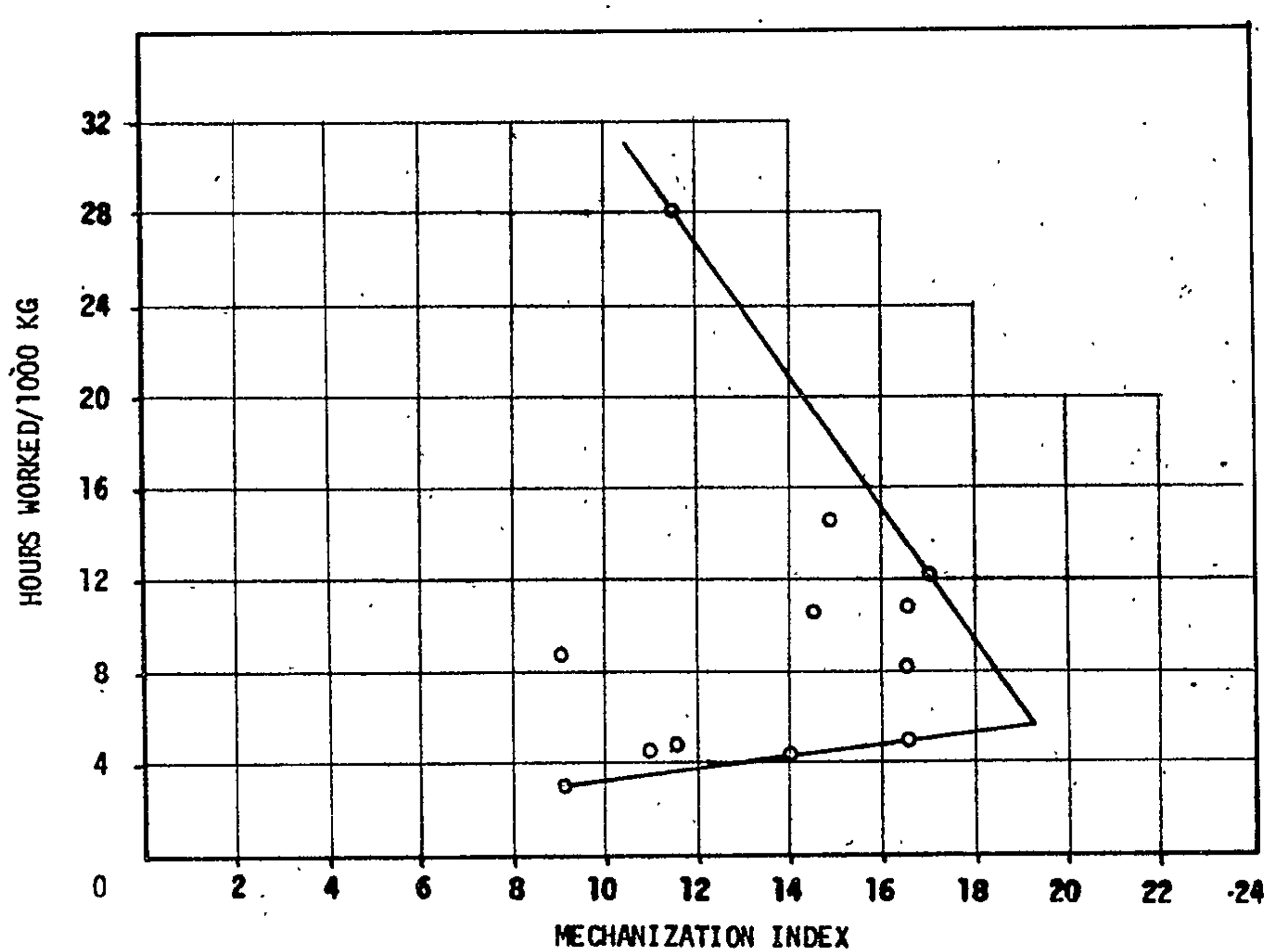

Figure 3-24. Mechanization Vs Terminal Productivity

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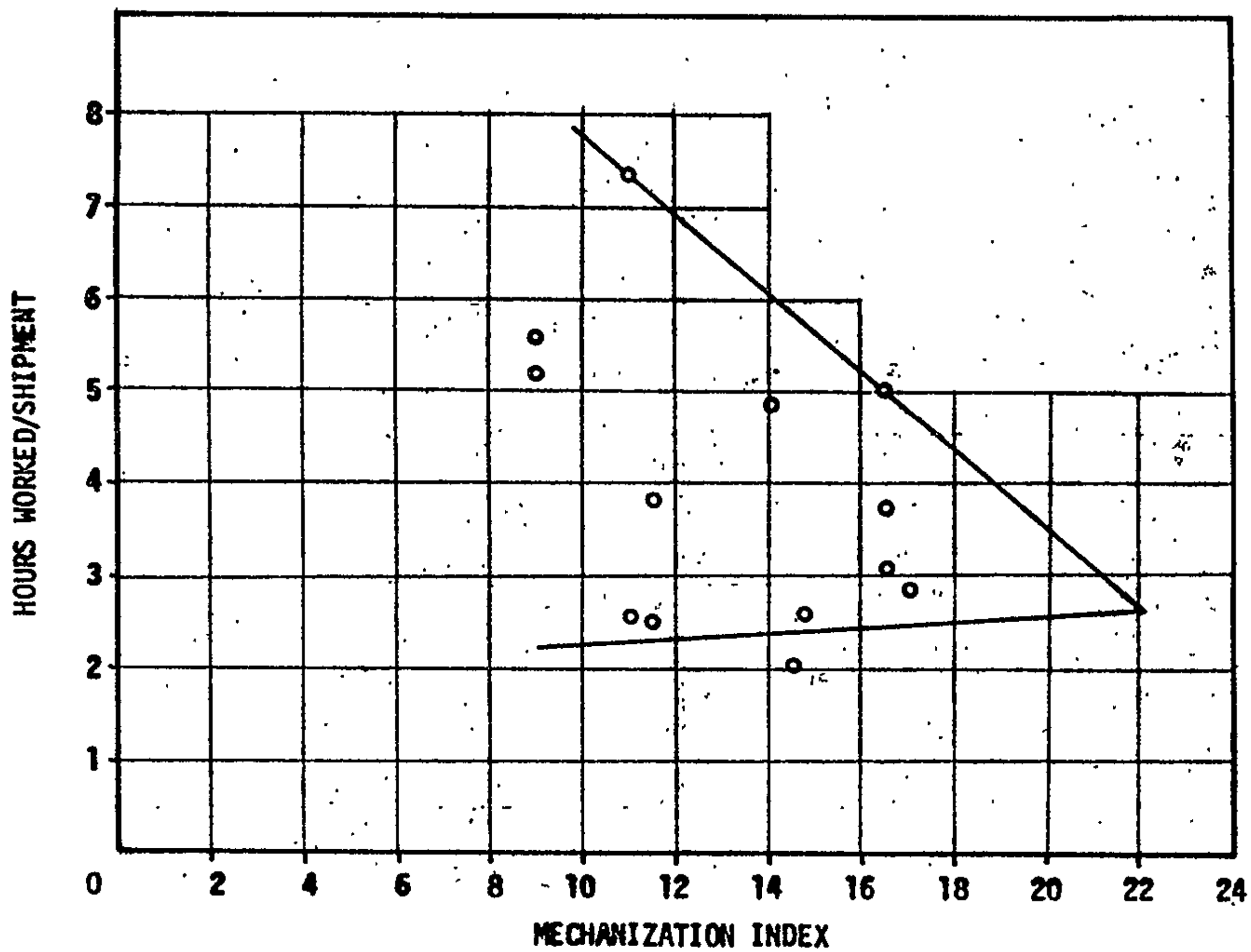

Figure 3-25. Mechanization Vs Terminal Productivity Shipment Base

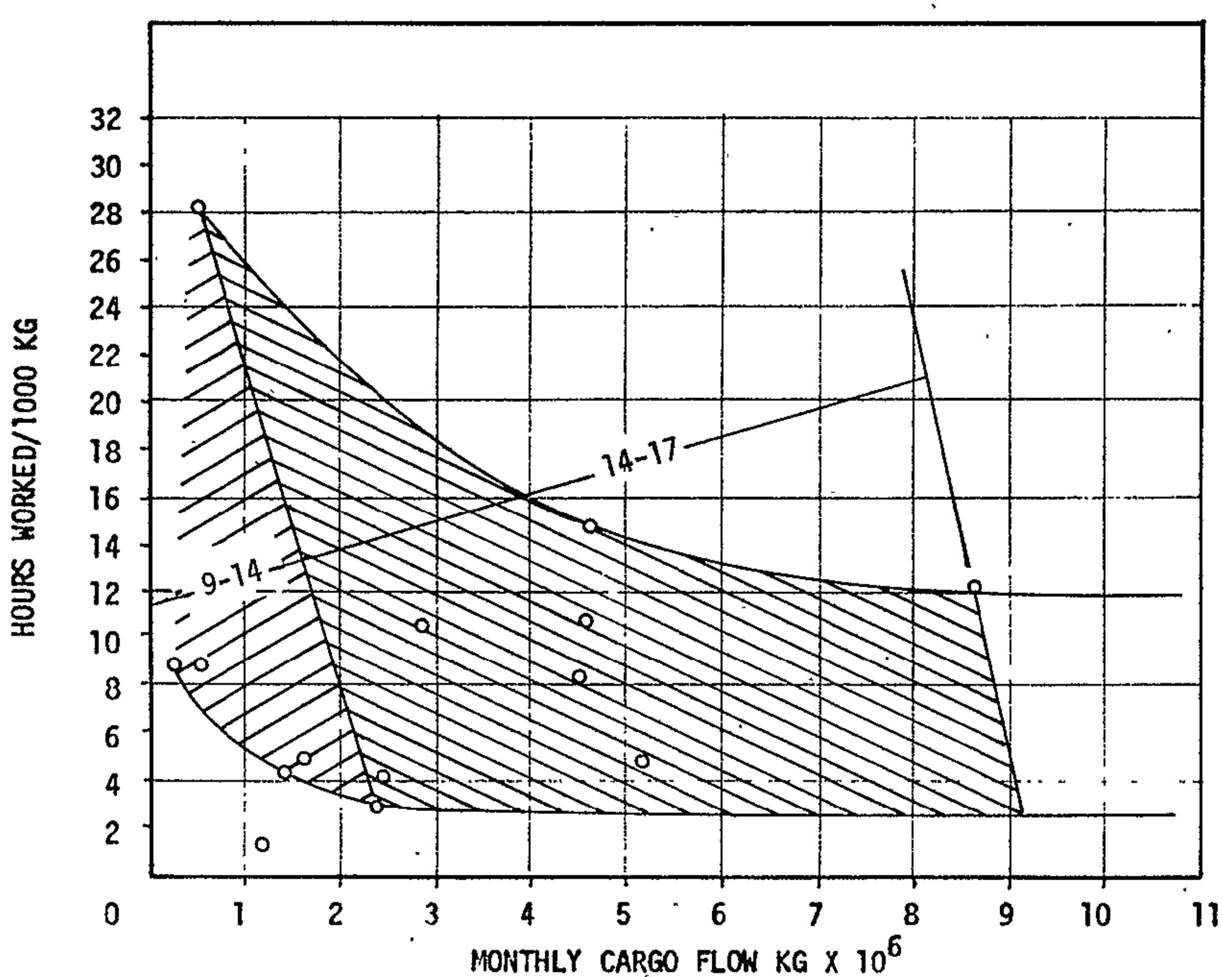

Figure 3-26. Monthly Cargo Flow Variations

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flow versus man-hours per 1000 kilograms. The terminals with low mechanization and low flow cover a broad personnel productivity range. The most productive terminals in this range are primarily CLC operations. As the flow and mechanization levels increase, the range of hours per unit flow tends to decrease causing an improvement in productivity.

Three mechanization ranges were determined to exist on the plot of hours per 1000 kilograms as a function of cargo flow per unit terminal area. On Figure 3-27, the mechanization range from 9 to 11 points produces the lowest hours per unit flow and lowest flow per unit area. However, this range correlates with small domestic freighter terminals heavily involved with CLC movements and is probably the critical factor. Medium mechanization, from 11 to 15 points, covers the broadest spectrum of personnel and terminal area productivities. It roughly corresponds to the lowest levels of CLC flow. Finally, the highest mechanization levels are confined to a small intermediate band roughly corresponding to low to medium levels of CLC flow. With more data points, it is quite possible that the medium and high mechanization level bands would continue the trend downward and to the right. It may be concluded that higher levels of mechanization have a tendency to improve both personnel and terminal area productivities in current operations. However, CLC processing levels are as important as mechanization levels, particularly with respect to personnel productivity.

Cargo terminal constraints and trends. -- Nearly all current terminals are at maximum physical size and cannot expand at present sites because of airport restrictions or lack of available adjoining land. New construction is expensive and capital is limited. If a site is available on the airport, it may be in a less desirable location from the aspects of construction cost, service road and taxiway accessibility, and efficient surface distribution of cargo. While a small number of the surveyed terminals were operating at half capacity, most stations were operating at 70 to 80 percent of capacity under the present scheduling, flow composition, and system/equipment conditions. Flow through the terminals can be increased through suitable modification of the operating conditions.

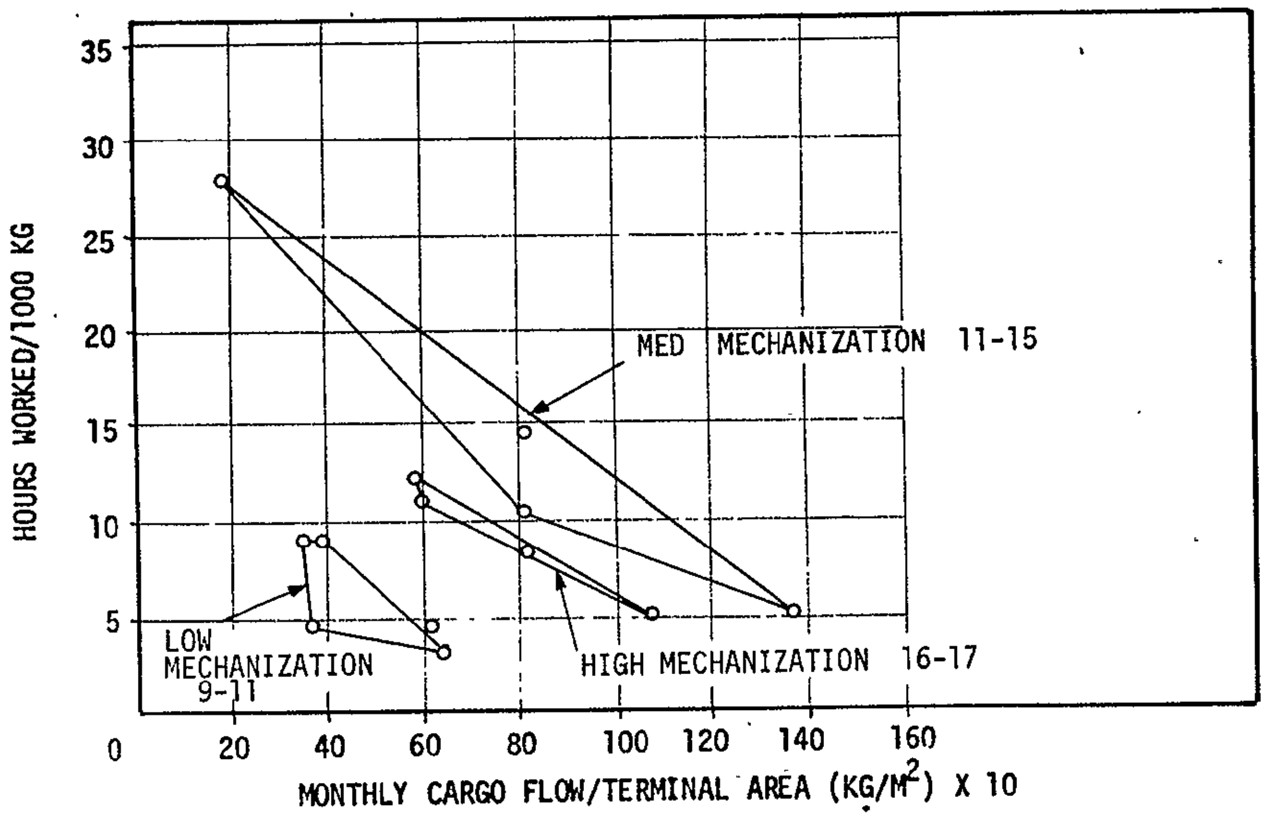

Figure 3-27. CLC Mechanization Ranges

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Aircraft scheduling plays a major role in establishing peak flow demands on cargo terminals, particularly with freighter operations. Theoretically, terminal capacity could be increased by providing cargo service at off-peak hours. Domestically, cargo service is provided in varying levels on passenger aircraft during the day. The market has been stimulated with daylight container rates, but the operation is only marginally profitable using passenger aircraft. The consensus appears to be that a freighter cannot be operated profitably in competition with passenger aircraft daylight rates. Some domestic daytime freighter flights are used to reposition aircraft and carry international transfer cargo and problem (oversize, live animals, etc.) cargo when scheduling is less severe. The domestic daytime cargo market remains to be developed. On international cargo movements, the demand for overnight delivery is not severe. However, flights must be scheduled for the airport operating hours, flight quotas, and connections which limit flexibility of operations at the stations involved. This problem may soon become more of a problem domestically. The demand for service on particular routes must be sufficient in both directions to justify the added capacity. The wide-body combination aircraft is being employed on many international routes to minimize fuel use, hedge passenger and cargo demand (at least seasonally), and meet airport constraints. Aircraft scheduling can play only a minor role in balancing terminal operations to achieve higher capacity levels.

Somewhat akin to aircraft scheduling is the concept of joint operations. With joint operations, two or more airlines operate from the same facility to improve terminal, equipment, and personnel utilization, thereby reducing processing costs and land demand. This concept is used in Europe where the national airline and/or airport authority provide partial to complete cargo processing operations. In the U.S., airport authorities have preferred to do little other than perhaps serve as a landlord for terminal buildings. Independent businesses and major airlines provide contract services at most of the major U.S. airports for other airlines with limited operations. The most common contract service is to provide the ramp, loader, and crew for aircraft offload-onload activities. However, services can range all the way up to complete cargo processing when terminal and ramp capacity are available. Most airlines are actively seeking to perform more contract operations, but contract operations only account for about 5-10 percent of the terminal throughput at best. Capacity availability and compatible scheduling are the keys to contract services/joint operations. Certain airline personnel felt that an international carrier can only service another international carrier because of selectively standard processing procedures and equipment. Others felt that international and domestic operators would be compatible because of the differences in operating schedules. Another opinion was that belly-pit-only and freighter-only operators would be compatible. Joint operations would require detailed analyses at each airport to establish flight schedule compatibility. Then a complete reformulation of airline processing procedures would be required to achieve efficient operations between two or more airlines. Joint operations, which can make any significant impact on airport land demands, appear to be far in the future in the U.S. Perhaps as terminal capacity reaches saturation there will even be a trend away from joint operations/contract services.

Offsite bulk-cargo processing operations could free a significant amount of airport area for aircraft loading and ULD storage/staging functions. The throughput per unit of land area would be many times greater than with conventional terminals. Highly efficient mechanized container handling and aircraft loading systems could be provided on the airport for individual or joint airline use. Even truck traffic could be reduced. About eight trucks could service a 91 000-kilogram aircraft payload while 100 or more would be required if only bulk, unconsolidated shipments were handled. Offsite bulk-processing facilities are generally considered to be unworkable by airlines using passenger aircraft to transport cargo. The advent of the wide-body aircraft and daylight rates has increased the domestic movement of small CLC containers, but the heart of the passenger aircraft operation is still the small-bulk shipment. The cargo terminal must be in relatively close proximity to the passenger terminal to facilitate the movement of many small loads between the aircraft and cargo processing center, particularly when transfer shipments are a major part of the flow. Freighter operators expressed more interest in the potential of the off-airport bulk-processing terminals, but generally indicated the management of a split operation would require extremely strong planning. Further, split operations would tend to reduce personnel productivity since they could not be easily exchanged between ramp and warehouse functions.

The most promising approach to off-airport operations appears to be for processing of import cargo. The time differential for moving import cargo to an offsite processing center would be insignificant. Since 35-45 percent of inbound international cargo is transfer, cargo would either have to be segregated at upstream stations with a possible reduction in ULD utilization or broken down at the airport terminal with some loss in effectiveness for the offsite operation. Breakdown in the airport terminal could result in multiple handlings. It could be minimized by placing the shipments directly into storage bins after breakdown and verification to facilitate mechanized handling onto and off the truck and into storage. Additional handling and transportation, lower personnel productivity, as well as cost and availability of offsite warehousing space will have to be evaluated against the cost and demand for the area occupied by import cargo storage at each airport cargo terminal. A trend towards any offsite operations at the surveyed stations does not appear imminent for the near-term period.

Continued growth of CLC movements may preclude the necessity for airline offsite operations. The freight forwarders will process increasingly greater amounts of bulk cargo at their predominately off-airport facilities. Most airlines generally favor this trend, providing the rates ensure an adequate return for loading, flying, offloading, and staging the ULDs. Domestically, the rates have fostered CLC growth and provide marginally adequate return to the airlines. Most CLC growth has been from forwarders and as their strength continues to grow, the rates may come under heavy downward pressure. Conversely, container rates for international cargo have been too high to foster much growth, particularly when combined with customs restrictions. International cargo generally places the highest demands on terminal area. Customs and rates for international CLC movements require extensive evaluation from the terminal capacity standpoint.

As has been noted in previous terminal analyses, high CLC involvement produces excellent personnel productivity even with low levels of mechanization. As the level of mechanization is increased to handle high CLC flow levels, excellent efficiencies in the use of terminal area will also result. CLC operations help reduce track congestion on service roads and on terminal truck ramps, particularly with a well-designed bypass system. Improvements in CLC handling are planned or underway at many surveyed stations. Mechanized CLC bypass systems should be integrated with ULD storage and staging systems and equipped with scales at the point of truck transfer. A bypass system of this nature would reduce transport, truck loading/offloading, and staging/storage times as well as reduce manpower expenditures. Because of differing physical constraints, each terminal will require specific study, facility modifications, and equipment to achieve these goals. Large-container and large-piece handling systems must also be integrated into the terminal processing systems to meet the capabilities of the growing wide-body freighter and combination fleets. Present handling systems are primitive for large containers and pieces and require extensive area and personnel commitments. Any new terminal facilities and systems must be conceived with CLC processing as a primary terminal element.

Mechanization has been found to improve personnel and terminal area productivities particularly when integrated with CLC operations. Mechanization requires standardization of the items to be handled. Hence, its application to ULD handling in many current terminals is natural. Multilevel stacker systems maximize storage for a given area and retain the capability for fast access with a minimum of manpower. Raceways also minimize area, time, and personnel for movement of ULDs between the stacker and other functional areas such as buildup/breakdown positions and truck docks. Raceways are directional and may reduce operational flexibility, so they must be integrated into a processing system with care and only if proper interfaces cannot be achieved directly with the stacker system. Mechanized ULD handling systems are expensive and may not achieve enough reduction in personnel expenditures to produce lower total processing costs than with manpower intensive storage/staging systems. At this stage of the investigation, one must place greatest emphasis on area conservation for mechanized ULD handling systems.

Computer systems are used by most major airlines today to track shipments and to process, develop, and transmit airbills and manifests. All surveyed airlines used computerized central accounting systems for tasks such as billing. There is still considerable potential for exploiting the computer with respect to shipment control and load planning tasks. The former would be mainly procedural. The latter would require extensive development to accommodate weight, volume, and handling restriction parameters to plan and achieve optimum loads by integrating functions from sales through load buildup. International operations have lagged domestic operations in the application of computer processing and data transmission technology. These facilities are expected to become increasingly available in the immediate future. Considerable improvement appears feasible in computerized processing and transmittal of customs documents with particular emphasis on integration of the extra data directly on the airbill.

Terminal capacity was often constricted because of bulk-cargo storage practices. Outbound cargo was stored on the floor prior to buildup operations at all terminals. Terminating domestic cargo was also stored almost exclusively on the floor. At some terminals there was no physical separation of outbound and terminating cargo. While air cargo theoretically flows through the terminal, enough residual cargo accumulates for several hours up to several days to congest the storage/staging areas with present single-level storage/staging practices. As congestion builds up, shipment identification and accessiblity are hampered, thereby reducing the efficiency of related functions such as load buildup/breakdown and truck offload/onload operations. Congestion can be reduced and capacity increased by the following:

- Transfer large, uniform bulk-cargo pieces directly between the truck and aircraft ULD.
- Load large pieces of cargo directly onto an aircraft ULD upon receipt to form the baseload with topoff later during load buildup.
- Store large-piece shipments and large uniform-piece shipments in the ULD storage system until further processing (truck loading, aircraft loading, load topoff) is required.

- Consolidate small-piece outbound shipments into bins by destination, preferably in close proximity to the truck docks.
- Segregate medium-sized shipments in bins or on warehouse pallets.
- Store shipments on multilevel racks if load buildup or customer pickup is not in progress. Rack segregation would be by destination for outbound loads and by type customer and/or airbill number for terminating shipments. Storage racks for terminating cargo should be graded by piece and shipment size.

These procedures will free floor area for greater throughput and faster accessibility with little, if any, extra handling. These procedures would provide necessary physical separation of inbound and outbound cargo even when both are using the same floor area. Import cargo is already being stored using these techniques at most terminals because of the longer dwell time. However, area productivity could be improved for import storage through use of narrow-aisle reach forklifts, appropriate bin and rack sizes, and possibly mechanized stacker systems.

Mechanization for other functions does not appear to provide any near-term increases in productivities. Flow levels must be increased significantly or the physical cargo characteristics severely restricted to provide compatibility with mechanized sortation and distribution of bulk cargo. This would require a complete restructuring of the normal air cargo business.

Continued or improved maintenance will help to accommodate future increases in cargo flow. About half of the surveyed terminals had marginal maintenance practices. That is, a piece of equipment was attended to only when it broke down. Preventive maintenance was not a particularly strong point with most airlines, and one airline operated with aircraft handling systems that were nearly inoperative. Poorly performing equipment reduced system performance. Deferral of maintenance can provide short-term gains in cash flow, but proves to be expensive over the long term. At some stations, considerable terminal and ramp area was occupied with broken-down equipment and ULDs which were being stored prior to repair. Maintenance facilities should be separated from the major processing area and can use regions on the terminal plot which are of little value for the major activity. Some terminals were taking steps to improve operating efficiency and to reduce maintenance. Transfer vehicles were being converted to electric power from internal combustion engines. Gasoline-powered forklifts were being replaced and/or modified for electric, diesel, or LPG power. Some terminal buildings were being repainted with light-reflective paint and/or adding better lighting to reduce pilferage and increase operating efficiency.

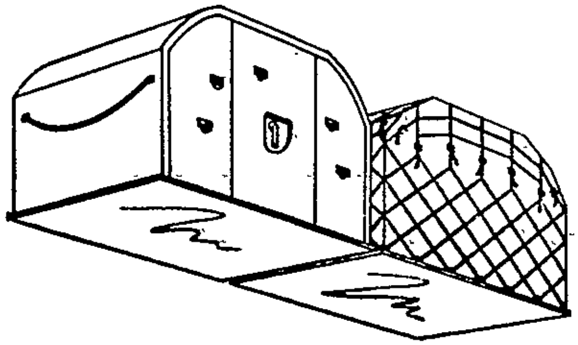
Due to environmental constraints, lack of suitable land, and marginal capital availability, there appears to be little hope for new airports in the surveyed city regions. In fact, little interest in all-cargo airports was expressed by the airline personnel interviewed. Combination and belly-pit operations view an all-cargo airport as impractical. Freighter operations for combination operators are considered to be too closely integrated with passenger aircraft operations. Freighter-only operators question whether any cargo would be delivered to remote airport locations and who would pay for the additional surface transportation costs. At some point in the future, predominately all-cargo airports may develop as hubs for large, long-range freighters. At these hubs, ULD transfers will be made with feederline freighter aircraft serving existing airports in major geographical regions. In the near term, cargo operations will remain at present sites and in some cases, expand into whatever remaining undeveloped land is available. Near-term cargo processing operations will expand through evolution with more-productive procedures, equipment, and systems concepts.

Effectiveness of Unit Load Devices

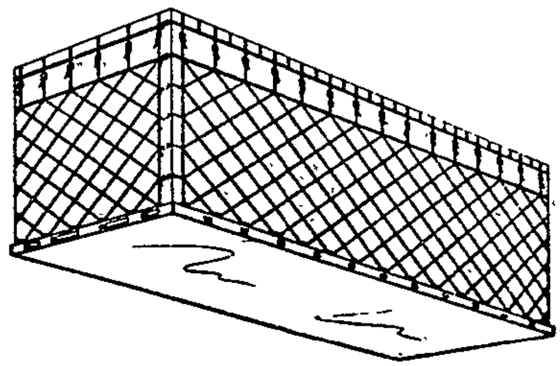
Unit load devices (ULDs) have proven within limits of scale to be highly beneficial in the reduction of handling and transport costs in cargo distribution networks. Their use has also resulted in peripheral benefits such as reduced pilferage and reduced damage from weather depending upon the type of ULD. These benefits have accrued regardless of whether the transport mode is land, sea, or air.

ULDs basically enable the consolidated containment and handling of a multiple of individual pieces (or smaller ULDs), either homogeneous or heterogeneous in physical characteristics, as a single item. In a broad academic sense, the ULD can be as small as a cardboard carton having two dozen boxes of laundry soap or as large as a maritime container. The net result in use of the ULD is an order(s) of magnitude reduction in costly man-piece handlings in moving a quantity of items from a shipper's dock through a transport and distribution system to a consignee's receiving dock.

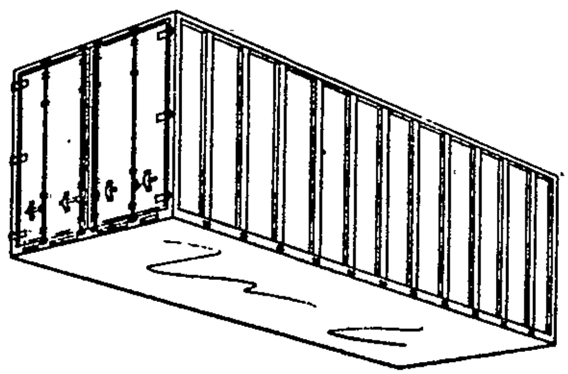
Definition of current ULDs. - The ULDs covered in the following discussion will be confined to those types which are physically and functionally compatible with existing aircraft loading and restraint systems. They meet all restraint requirements without the use of supplementary equipment, and may be either a combination of components acting as an integral ULD or a single component designed as one complete structural unit. The combination units consist of (1) pallet plus net or straps, and (2) pallet plus non-structural igloo plus net or straps. A structural unit is a container or structural igloo assembly which meets design load and strength requirements without the need for supplemental netting or straps. All combination and structural units have flat bottoms for roller conveyor handling and are designed to latch at their lower edges into the aircraft on-board restraint system. Representative ULDs are illustrated in Figure 3-28.



224 X 318 CM (88 X 125 IN.) CONTOURED
CONTAINERS AND PALLETS



244 X 244 X 606 CM (8 X 8 X 20 FT)
RECTANGULAR PALLET



244 X 244 X 606 CM (8 X 8 X 20 FT)
RECTANGULAR CONTAINER

Figure 3-28. Representative Air Cargo ULDs

Standardization: An unfortunate aspect of airlift ULDs has been a considerable variety in size and shape. This has been influenced principally by marketing considerations, shipper's interests, and the aircraft types in which they will be used. In the latter case, these influences relate to floor widths, fuselage cross section-shaped contours, fuselage longitudinal tapers forward and aft of the constant cross section, cargo loading door dimensional limits, and payload/range limits with respect to cube or weight limited considerations. Even with this large number of variables, a considerable amount of air mode standardization of ULDs has been achieved by the aircraft operators and manufacturers through common performance standards and practices. For instance, nearly all freighter aircraft are derivatives of passenger aircraft which were sized to accommodate the passenger influence on ceiling heights and on cabin widths in terms of abreast seating and safe aisle widths. This has resulted in ceiling/door heights that generally limited ULD heights to the 80- to 85-inch range and in floor widths that enabled standardization on the common 125-inch pallet length.

Perhaps the biggest influence on ULD standardization has been the economic necessity for intra- and interline transfer of ULDs. This has become more evident with the increase in shipper-loaded ULDs and routing alternatives wherein the ability to transfer ULDs from one aircraft type to another while maintaining load integrity is essential. Evidence of interline transfer needs is witnessed by the increasing number of such agreements between international and domestic air carriers to ensure secure and expeditious cargo movement. This also enables bypassing of significant elements of gateway customs procedures to locations closer and more convenient to the consignee.

In the further interest of promoting standardization, all design requirements which must be met for pallets, igloos, and containers for various certifications and aircraft systems are compiled into one manual. This is the "IATA Unit Load Devices Manual" which was developed through collaboration with pallet container manufacturers and the aircraft industry. Also, an alphabetical identification for basic pallet base sizes is currently in use domestically. This code is set forth in "National Aerospace Standard - NAS 3610".

This defines the minimum performance, design, and test requirements for ULDs to be installed in certificated aircraft for the basic sizes listed in Table 3-7.

TABLE 3-7
NAS 3610 BASIC ULD SIZES

Size Code	Nominal Dimension
A	224 x 318 cm (88 x 125 in.)
B	224 x 274 cm (88 x 108 in.)
C	224 x 300 cm (88 x 118 in.)
D	224 x 137 cm (88 x 54 in.)
E	224 x 135 cm (88 x 53 in.)
F	244 x 299 cm (96 x 118 in.)
G	244 x 606 cm (96 x 238 in.)
H	244 x 913 cm (96 x 359 in.)
J	244 x 1219 cm (96 x 480 in.)
K	153 x 156 cm (60 x 61 in.)
L	153 x 318 cm (60 x 125 in.)
M	244 x 318 cm (96 x 125 in.)

Pallets: While being designed to meet specific requirements of aircraft systems and customer needs, pallet fabrication materials, processes, and joining methods will vary among different manufacturers. Typical basic construction consists of a pallet core which is enclosed on its four sides with extruded aluminum alloy edges joined at the corners by separate pieces. The maximum pallet thickness is 1 inch, and its edges have receptacles for net or strap tiedown fittings. Thickness, overall dimensions, and edge configuration are controlled to ensure compatibility with aircraft latch restraint systems. Material selections are based on weight, design loads, durability, corrosion resistance, and suitability for roller conveyor handling. The most commonly used pallets and their design gross loads are:

Size B	224 x 274 cm (88 x 108 in.)	3629 kg (8000 lb)
Size A	224 x 318 cm (88 x 125 in.)	6033 kg (13 300 lb)
Size M	244 x 318 cm (96 x 125 in.)	6804 kg (15 000 lb)

Pallets meeting the above requirements are certified accordingly. Additional components used in conjunction with the pallets such as nets, straps, tiedown fittings, and special adapter bases must also be designed and certified to the same load requirements. Thus, the combined units offer total structural integrity.

Igloos: Netted nonstructural igloos on pallet bases and structural igloos with integral pallet bases are contoured and are designed to meet the same load requirements as netted pallets. The igloo contour may vary depending upon the specific aircraft and its fore/aft position in the aircraft. Examples affecting specific contours relate not only to specific fuselage cross-section internal structural geometry, but other factors such as convertible aircraft, quick-change (QC) aircraft, rapid-change (RC) aircraft, and stripped-out freighter aircraft. These variations manifest in additional discrete clearance requirements such as those imposed by up or down stowed positions of coat/hat racks (QC/RC aircraft), service or utility ducts and tunnels, and interior liners.

Containers: As a generic group, containers are integral units designed to meet the same load requirements as pallets and igloos, but without supplemental netting or straps. As such, contoured structural igloos noted in the preceding are often discussed as containers. However, this group also includes noncontoured rectangular containers, such as the airline designated M1 and M2 containers, and wide-body aircraft lower deck containers, such as the LD-3, having their lower outboard sides angled upward and outboard to maximize available cube. Design details of the M1 and M2 container bases may vary from the basic pallet edge configuration to include latching provisions for the SAE AS-832 restraint system.

Utilization of ULDs. - Through the CLASS Study questionnaires and terminal surveys, primary ULDs in use by the surveyed carriers have been identified. The most frequently used is the type A ULD which accounted for 50 percent of all ULD movement. This finding is consistent with the fact that 72 percent of all-freighter flights are by narrow-body aircraft. The most commonly used ULDs from the survey results were found to be:

ULD	Percentage of Total Flow
Type A	50.50
LD-3	25.50
LD-5/-7	18.50
M1	4.50
M2	1.00

The percentages given total 100 percent, but are representative of the questionnaire sample only which consists of the most frequently used ULDs. Other ULDs are shipped by carriers, but frequencies are small and erratic. Typical of the others in use but not reported as frequently used are half-width pallets and engine transporting pallets.

Table 3-8 shows the percentage of shipper-loaded cargo as a function of total cargo flow for each carrier surveyed. According to these data 37 percent of the total cargo flow is shipper-loaded ULDs. This is only slightly greater than the percent shipper-loaded ULD flow established by the "1972 U.S. Domestic Air Industry Study" which was 32 percent for the same carriers. This shows a modest increase in cargo flow by percentage weight of shipper-loaded ULDs. Though small, this trend is beneficial to the carriers in the way of incrementally reduced piece/shipment handling and processing costs.

Cube Utilization: Cube utilization, or its synonmous term, stacking efficiency, represents as a percentage the amount of ULD available internal volume actually occupied by cargo. If effective unitizing procedures are employed and if sufficient cargo is available, the cube utilization for pallets and igloos can be improved to an optimum of approximately 85 percent

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TABLE 3-8
SHIPPER-LOADED ULD FLOW

CARRIER	CARGO FLOW KG/MONTH	% TOTAL FLOW	SHIPMENTS PER MONTH	% TOTAL SHIPMENTS
1	2 433 784	47.71	1138	13.63
2	1 602 561	35.50	772	7.93
3	1 857 895	41.44	1173	11.65
4	484 372	50.82	203	10.65
5	1 118 559	78.54	339	38.02
6	1 665 100	68.74	666	31.25
7	305 154	60.55	179	20.67
8	68 530	32.20	43	12.70
9	1 272 138	53.92	706	24.48
10	859 167	10.00	3750	10.30
11	-	-	-	-
12	-	-	-	-
13	-	-	-	-
14	907 941	20.00	-	-
15	150 079	5.26	131	0.90
16	-	-	-	-
17	-	-	-	-
18	-	-	-	-
19	-	-	-	-
20	352 589	14.00	138	4.02
21	291 331	23.88	131	4.10
22	547 259	40.03	175	7.41

provided that the gross weight limit for the ULD is not exceeded. This is graphically shown in Figure 3-29 which relates how the buildup of loads using selective procedures and having enough cargo to fill the container are means by which cube utilization can be improved. These curves are from actual tests using scale cargo and containers as documented in report MDC J5382 "Analysis of Cube Utilization and Potential for Improvement." The buildup of ULDs with large heavy items improves their weight utilization but reduces their cube utilization because the ULD will gross out before it cubes out. Conversely, small light cargo will tend to cube out the ULD before it grosses out. Recent studies, DAC 66616 "Commercial Cargo Characteristics Study," and MDC J7034 "A Survey of 1975 Air Cargo Characteristics," have indicated a reduction trend in stacking efficiency. In 1968-69, the stacking efficiency for the mean ULD shipment was 56.8 percent versus 53.7 percent in 1974 versus 50.7 percent in 1975.

Density utilization: Loaded density, as the product of warehouse cargo density and stacking efficiency, provides the best overall measure of utilization. Furthermore, it is not directly influenced by ULD type or size. Onboard loaded density is representative of ULD type and size as well as the cargo utilization density. The onboard loaded density has decreased since 1969; 153.7 kilogram/cubic meter in 1969, 140.9 kilogram/cubic meter in 1974, and 121.73 kilogram/cubic meter in 1975.

Cube and density utilization for 1976 were not calculated since sufficient information on ULD types, volumes, and individual closeout weights was not obtainable from the survey data. However, a comparison of loaded densities from the 1969 and 1975 data indicates a reduction from 139.4 kilogram/cubic meter in 1969 to 104.1 kilogram/cubic meter in 1975.

In viewing the various adverse trends above, it could be erroneously concluded that cube utilization (stacking efficiency), loaded density, and onboard density will continue to diminish. This will not be the case, however,

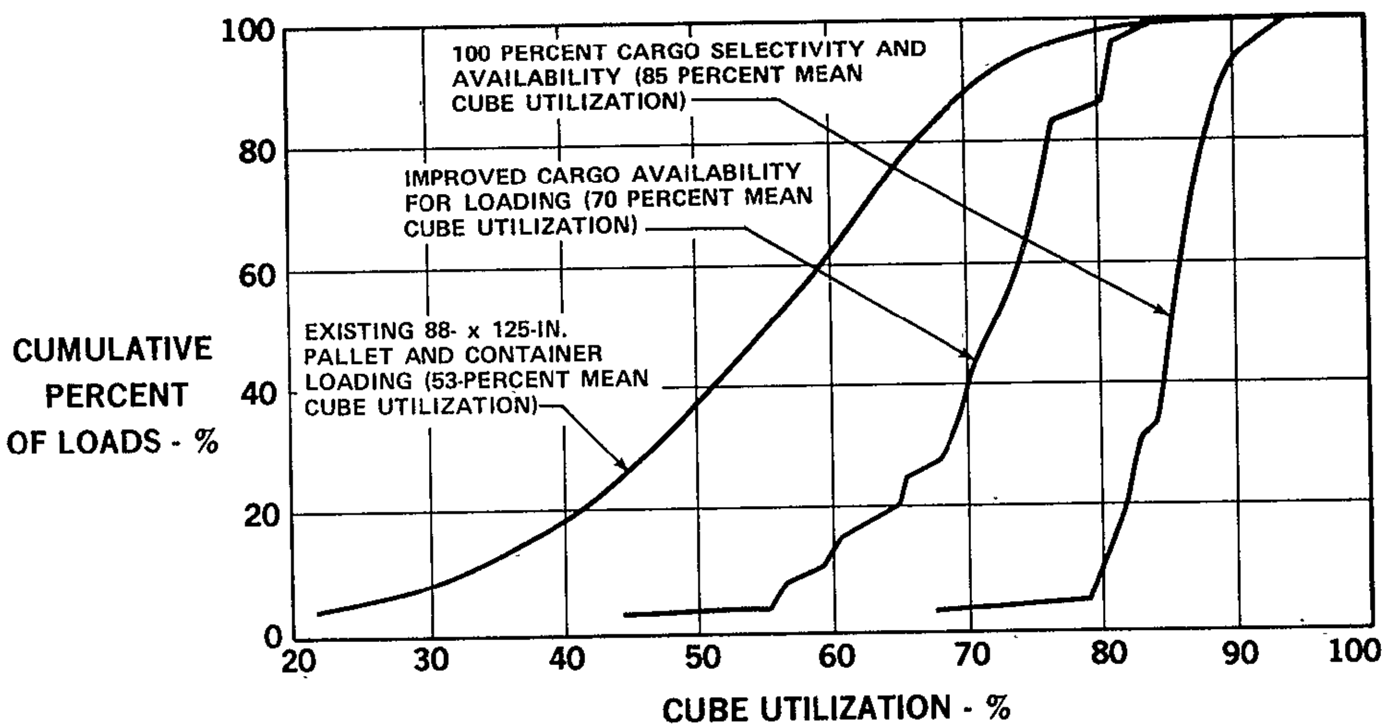


Figure 3-29. Type A Container Cube Utilization Improvement Summary

since improvements can be made as previously illustrated in Figure 3-29. In fact, economic forces coupled with the necessity for improved energy utilization will reverse the trends. The airlines must realize a reasonable return on investment which implies more cargo carried per dollar. In similar manner, more net cargo airlift must be realized per liter of fuel. This can only be achieved by increasing the net payload utilization such that the total fuel consumption per flight is spread over an increased amount of cargo payload.

Economic evaluation of ULDs. - Almost all main-deck cargo is shipped on pallets or in containers. The preference for pallets or containers varies between airlines; however, most freighter flights are found to have both pallets and containers because of interlining, shipper-loaded ULDs, and/or immediate ULD availability. There is a wide range of reasons why one main deck ULD is preferred over the other. In general, pallets are the preferred main deck ULD for:

- Long stage lengths
- Large packages, ideally of the same size (homogeneous)
- Flights which are cube limited

Similarly, containers are generally the preferred main deck ULD for:

- Short stage lengths
- Small packages of varied dimensions (heteogeneous)
- Merchandise where pilferage and/or damage may be high
- Customers who ship large quqntities

These ULD preferences are due to the different characteristics of pallets and containers. The advantages of pallets are:

- Lower tare weight
- Lower purchase price
- Empties can be stacked in the terminal or, when dead-heading, in the aircraft if desired

- Better use of aircraft volume, particularly wide-body aircraft such as the B747 freighter
- Easier loading of large packages because access is from all sides

The advantages of containers are:

- Easier stacking of small packages with the resulting higher loaded density
- Less manpower is required in closing a container than when installing a net on a pallet
- Preference by customers who ship unit load quantities
- Provides more protection against pilferage and cargo damage

This economic evaluation of pallets and containers considers the following principal expenses:

Fuel: The container is heavier than the pallet, and this additional weight requires additional fuel. (This also reduces the potential revenue payload by a like amount.)

ULD maintenance and depreciation: Pallets and containers differ in initial cost, life, and annual maintenance expense. This study will assume that both pallets and containers are used the same number of times per year.

Manpower: Pallets and containers require a different number of man-minutes to build up and breakdown a load. This manpower difference depends upon the size of packages and the loading/unloading facilities and procedures. Pallets can be loaded from any direction which is often advantageous for large items handled by a forklift. Containers have an advantage for small varied-size packages because there are stacking surfaces to work to and there is less concern about the load shifting. Containers also have an advantage on closing out the load because it takes less time to close the container than to install the cargo net on a pallet. This study will not consider any difference in the manpower time required to load (or offload) the ULD into (or out of) the airplane.

Lost revenue: Some freighter flights go out at either maximum payload weight or with all the cargo space utilized. It is possible that there is some additional cargo which should go on the flight but cannot because the flight is weight or cube limited. The airline must send the overload cargo on a later flight which might delay receipt by the consignee.

Pilferage and damage: Cargo pilferage and damage is often a significant cost item. Containerized cargo has a lower claim expense than noncontainerized cargo whether it is shipped by truck, rail, ship, or airplane. The cost of claims is minimized when the customer ships the merchandise in a container that is locked from his dock until received by the consignee.

Cargo loading equipment: It is impossible to load a pallet through the nose door of a B747F if the cargo is stacked over 244 centimeters high. However, a pallet loaded up to 305 centimeters high can be loaded through the side door. This study will not include the extra cost of positioning loading equipment at the side doors because: (1) not all B747 freighters have both nose and side door loading capabilities; (2) the equipment for side door loading may interchangeably replace the equipment for nose loading; and (3) the side door loading equipment may be used for more than loading pallets on a B747 freighter.

Much of the data required for an exacting economic comparison of unit load devices is not available. For example, it would be necessary to conduct a controlled experiment to accurately determine the difference in manpower to build up a load on a pallet compared to that in a container. Similarly, there is insufficient operational experience to determine the life of B747 main deck ULDs. There are also conflicting data on many items such as the life of

DC-8/B707 main-deck ULDs. This is to be expected because of different maintenance and operating procedures employed by the users. Table 3-9 summarizes the basic ULD-related data with multiple-line entries representing different data sources for the indicated parameter. Cost calculations using the ULD-related data plus data that are not ULD specific are found in Table 3-10. It should be noted that the charts summarizing the economic comparison of ULDs do not include lost revenue nor pilferage and damage.

Lost revenue is not included because:

- Some airlines report a higher net weight on containers than pallets. This may be a reflection of container use preference and/or higher proportions of shipper-loaded containers.
- The frequency of flights which depart at maximum weight or cube is very route specific. The extra cargo which is at the freight terminal but cannot be shipped is unknown.
- The revenue lost by not being able to send cargo on the desired flight is very route specific; the fares are route and commodity specific; and the airlines ability to delay the cargo to the next flight depends upon route, commodity, shipper, and priority.

Pilferage and damage expenses are not included in the charts because:

- There is very limited data on pilferage reduction attributable to use of containers.
- The pilferage and damage reduction associated with containers may be mostly due to shipper-loaded containers which are locked from shipper to consignee rather than the airline using containers instead of pallets.

TABLE 3-9

ULD RELATED DATA

ITEM	DC-8/707 ULD		747F ULD	
	224x318 cm PALLET/NET	"A" CONTAINER	244x606 cm PALLET	244x244x606 cm CONTAINER
Initial cost (1977 $)	$850(P+N) 350P + 200N 550P + 300N	- 1800 -	$3925(P+N) - 3500P+425N	$9000 - -
Life (years)	5-7P; 1.5N .5-.7(P+N)	5-7 5		
Annual maintenance (1977 $)	110P + 80N	200		
Tare weight (kg)	122 (P+N) 109P + 32N	420	440	948-980
Manpower (total man-minutes)	78.8	50.8		
Manpower (differential man-minutes)				
Buildup: sm packages	+10			
lg packages		+ 5		
Install net vs. close container	+30			
Breakdown: sm packages		+ 0		
lg packages		+ 5		
Available volume (cu. m)	16.2	15.5	42.1*	33.4
Stacking density advantage		2%		2%

* Adjusted for 10-foot height

TABLE 3-10

ULD COST CALCULATIONS

COST ITEM	DC-8/707 MAIN DECK ULD			747F MAIN DECK ULD		
Fuel						
Extra fuel/1000 kg extra wt/ 1000 km	34.3 kg			29.7 kg		
Container wt - pallet wt	298 kg			508 kg		
Extra fuel for container/1000 km	13.02 liters			19.22 liters		
$ per 1000 km: 8¢/liter fuel	$ 1.04			$ 1.54		
10¢/liter fuel	$ 1.30			$ 1.92		
12¢/liter fuel	$ 1.56			$ 2.30		
ULD Maintenance and Depreciation	PALL	NET	CONT	PALL	NET	CONT
Purchase price	$550	300	1800	3500	425	9000
Years, life	5	1-1/2	6	5	1-1/2	6
Depreciation per year	110	200	300	700	283	1500
Maintenance per year	80		200	510		1000
Total per year	$390		500	1493		2500
Flights per year	350		350	350		350
Cost per flight	$1.11		1.43	4.27		7.14
Container extra cost/flight	$0.32			$2.87		

TABLE 3-10. - Concluded

ULD COST CALCULATIONS

COST ITEM	DC-8/707 MAIN DECK ULD		747F MAIN DECK ULD	
Manpower (differential: man minutes for pallet minus man minutes for container)				
Large packages: Buildup	- 5 man min		-15 man min	
Close	+30		+40	
Breakdown	- 5		-15	
Total:	20		10	
Pallet extra cost @ $12/hr	$4.00		$2.00	
@ $16/hr	$5.33		$2.67	
Small packages: Buildup	+10 man min		+30 man min	
Close	+30		+40	
Breakdown	0		0	
Total:	40		70	
Pallet extra cost @ $12/hr	$ 8.00		$14.00	
@ $16/hr	$10.67		$18.67	
	PALLET	CONT	PALLET	CONT
Lost Revenue				
Max. Available Vol (cu m)	16.23	15.49	42.06	33.36
Max. wt. at 143 kg/cu m (kg)	2314	2209	5997	4756
Max. payload advantage of pallets	105		1241	
Wt. per cu m with 2% cont advantage	141.5	144.5	141.5	144.5
Payload at above density (kg)	2296	2238	5952	4820
Payload advantage of pallets (kg)	58		1132	

Figures 3-30 and 3-31 summarize the cost comparison of ULDs based upon fuel, depreciation, maintenance, and manpower. Two parametric cost plots each are given for narrow-body ULDs and for B747F ULDs. The upper plots in each figure are based on the following assumptions which are most favorable for pallets:

- Large packages
- Labor rate of $12 per hour

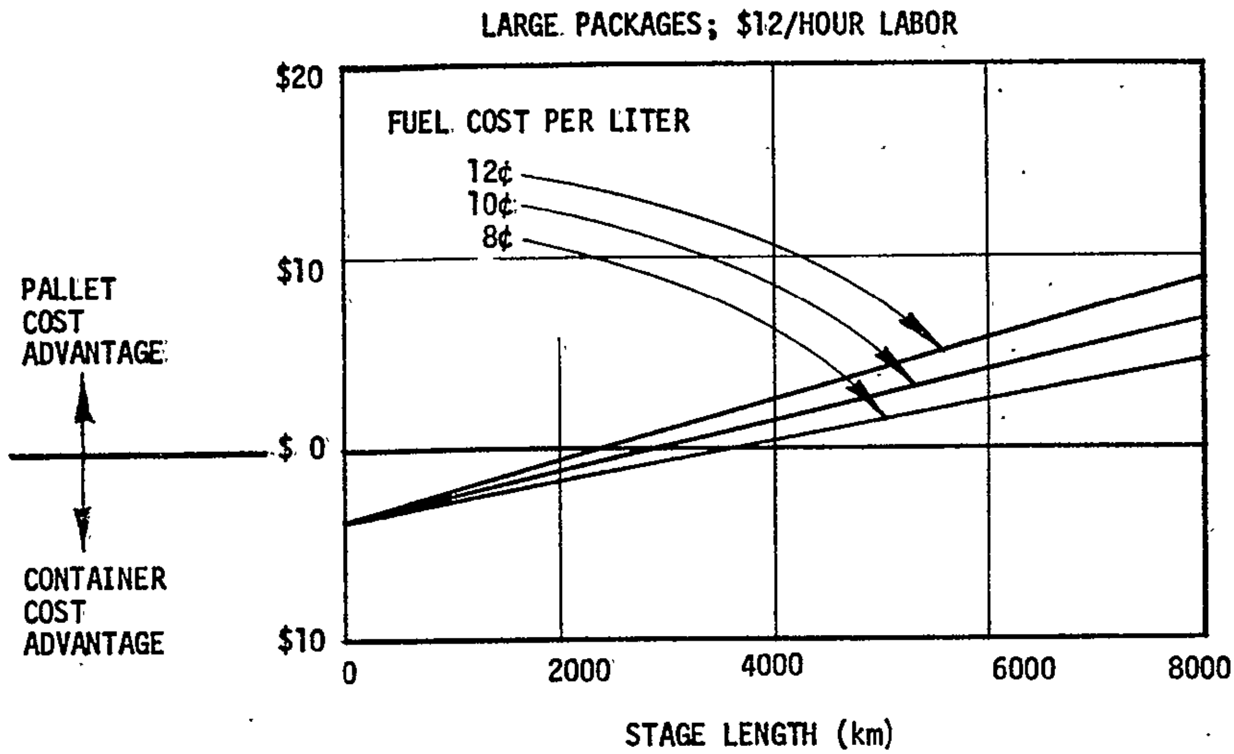
Conversely, the lower plots in each figure are based on the following assumptions which are most favorable for containers:

- Small packages
- Labor rate of $16 per hour

The ultimate decision to use pallets or containers depends upon the cost comparison given in the figures, lost revenue, pilferage, damage, plus shipper preference and frequency of shipping full-container quantities.

<u>Primary conclusions</u>.- Even though comprehensive 1976 loaded density data was not acquired in the surveys, on site observations tended to indicate that loaded densities are still down. This is probably a reflection of the guarded economy, the high cost of fuel and its impact on cargo tariffs, and the resulting throttling effect on freighter service levels. With the increasing belly-pit cargo capability in wide-body passenger aircraft, the amount of air cargo available to freighter aircraft has been substantially diluted which manifests as decreased loaded densities. That this trend must turn around has been commented on previously in this subsection.

As the trend does turn back upward, the acceptance of M1 and M2 containers and 244 x 244 x 318 and 607 centimeters pallet loads will be more widely felt particularly as wide-body freighter fleets increase. This positive thrust will



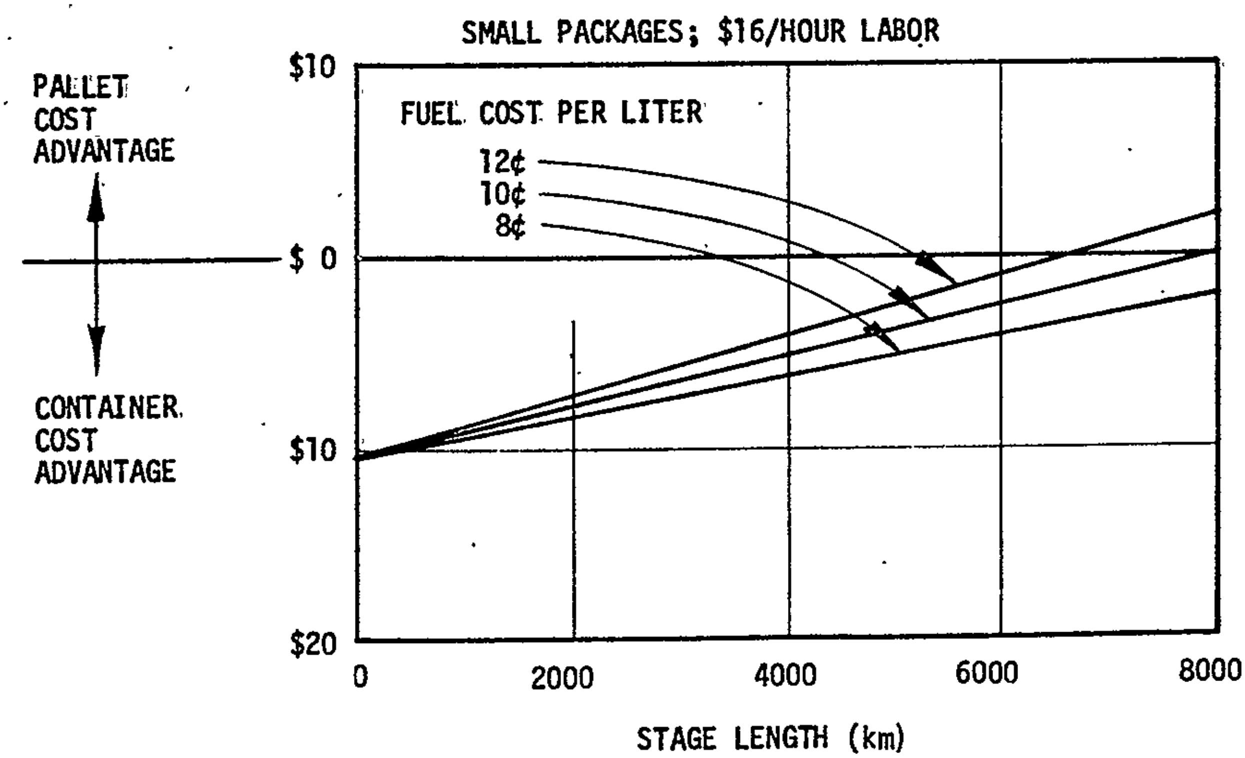


Figure 3-30. Economic Comparison of ULDs - Main Deck DC-8/B707 per 224 x 318 cm (88 x 125 in.) ULD per Flight

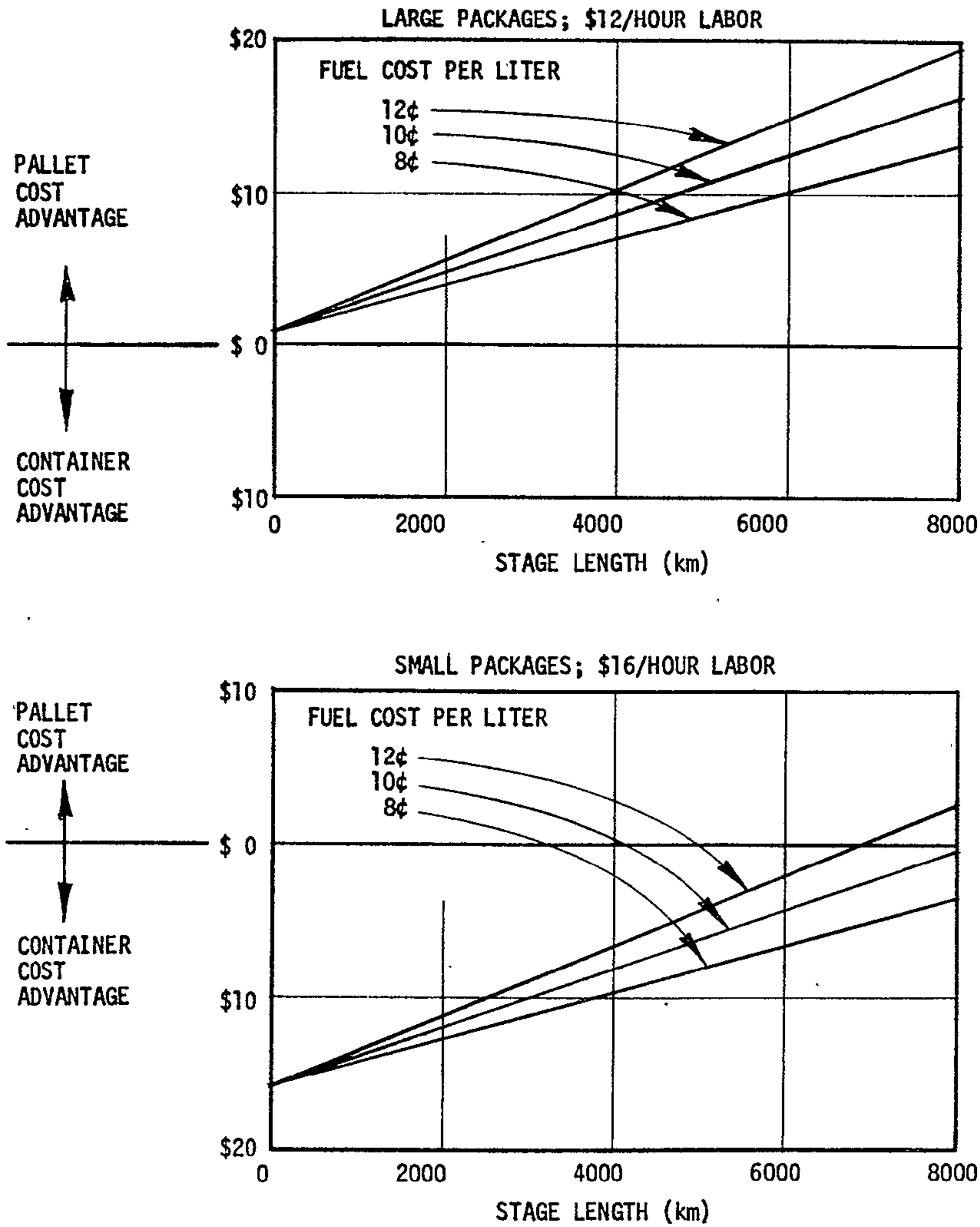


Figure 3-31. Economic Comparison of ULDs - Main Deck 747F per 244 x 244 x 606 cm (8 x 8 x 20 ft) ULD per Flight

occur because these larger ULDs enable higher utilization of the available main deck cube in wide-body aircraft such as the B747. Also, the lower direct operating costs achievable with wide-body freighters can prove a beneficial influence in holding tariffs in check. This then can attract additional cargo to airlift which will further the need for and use of the larger ULDs.

Notwithstanding the preceding, 224- x 318-centimeter contoured containers and pallets will remain in evidence for a long time. Even though not as efficient as the larger ULDs, they are well matched with the narrow-body freighter which will continue in use for some years to come. In fact, the proposed refan engine installations for narrow-body freighters will not only reduce emitted noise to acceptable levels and extend their useful life but will also lower their fuel consumption and direct operating costs. Thus, the narrow-body freighters can upgrade their economic competitiveness and prolong the need for the smaller narrow-body ULDs.

As shown in the economic evaluation, pallets are favored over longer ranges, and conversely containers are favored over the shorter ranges. If fuel costs continue to rise even beyond those plotted, pallets will be favored more and more. But also, if labor rates continue to rise beyond the $12 and $16/hour ULD buildup/breakdown costs used in the analysis (which seems assured), this will favor containers. Thus, the net result in the long run may be somewhat counterbalancing influences. This prospect has some validity since energy costs, basic industry costs, and labor costs will generally pace one another.

Another variable worth consideration is the effect of container tare weights and investment costs. If these can be reduced, two of the cost categories will realize an incremental shift toward favoring containers. The first, ULD maintenance and depreciation, will result in a smaller differential penalty in the container extra cost per flight. The second, the fuel cost penalty associated with the higher tare weights of containers will be reduced which will flatten the slopes of the cost curves (Figures 3-30 and 3-31) proportionately. This potential for weight and cost reductions is discussed later in this study.

Although not discussed specifically in this subsection, 244- x 244- x 606-centimeter maritime containers moving in the air mode are a rarity for nearly all carriers. Even with the few carriers that do handle them, the relative frequency is not high. Except for one carrier, the tendering of maritime containers for airlift is generally on an emergency or priority basis where delivery to the consignee has become time critical and justifies the extra costs associated with diversion to the air mode. These extra costs which are borne by the customer relate to differences in tariff rate structure and to the higher tare weights of maritime containers. These extra costs are further compounded by the fact that maritime containers must be placed and restrained on heavy flat-bottom slave pallets to enable handling on aircraft roller conveyor systems. Any future increase in the airlift of maritime containers is somewhat speculative and is probably most sensitive to breakthroughs enabling tare weight reductions.

Taken as a whole, it would appear that a subtle trend to increasing air cargo containerization will be in evidence. However, there will be carriers whose long routes and dominant commodity payload characteristics will continue to favor palletization. For such carriers, it remains to be seen whether economic forces, interline requirements, and/or technological advances will justify altering their present methods.

SECTION 4

COMPARATIVE MODE ANALYSIS

Air, motor carrier, railroad, and ocean freight transportation are compared in this section. The following characteristics of these modes comprise the basis for comparison: amount shipped, modal choice selection criteria, current tariff structures, transit times, and service factors.

Amount Shipped

The amount of freight shipped by the respective transportation modes is compared on the basis of tonnes and tonne-kilometers of manufactured goods transported domestically during 1972, Table 4-1 (Reference 1-1); tonne-kilometers transported domestically for years 1939 through 1975, Table 4-2 (Reference 1-2); regulated sector revenue for years 1940 through 1975, Table 4-3 (Reference 4-1); estimated revenue for years 1965 through 1975, Table 4-4 (Reference 1-2); and revenue per tonne-kilometer for years 1965 through 1975, Table 4-5. The data of Table 4-1 show that only a small portion of total freight is transported by air, 0.2 percent of the total tonne-kilometers; that the shipper groups which rely most heavily on airfreight are those dealing in communications products and parts, 12.0 percent of the total tonne-kilometers shipped, and in apparel and related products, 4.8 percent of the total-tonne kilometers shipped. The data of Table 4-2, as illustrated in Figure 4-1, show that airfreight volumes have increased more rapidly than either rail or truck volumes. The data of Table 4-3 illustrate that air-freight revenues, as a percent of total regulated freight revenues, have increased substantially over time increasing from 0.69 percent in 1950 to 3.12 percent in 1975. The data of Table 4-4, as plotted in Figure 4-2, illustrate that airfreight and truck revenues increased at similar percentage rates from 1965 to 1975. The data of Table 4-5, as plotted in Figure 4-3, show that air revenues per tonne-kilometer are substantially greater than either truck or rail revenues per tonne-kilometer.

TABLE 4-1

SHIPPER GROUP SUMMARY — PERCENT DISTRIBUTION BY MEANS OF TRANSPORT: 1972

Shipper Group	Tonnes	Means of Transport							
		All Means of Transport	Rail	Motor Carrier	Private Truck	Air	Water	Other	Unknown
	Thousands	Percent Distribution							
Total Tonnes	1 346 434	100.0	31.7	31.1	18.3	--	18.3	0.2	0.3
1. Meat and Dairy Products	38 653	100.0	18.8	41.7	39.1	--	0.1	0.1	0.2
2. Canned and Frozen Foods and other Food Products, except Meat and Dairy Products	139 692	100.0	50.7	20.3	23.0	--	5.5	--	0.5
3. Candy, Cookies and Crackers, Beverages, and Tobacco Products	52 602	100.0	15.4	25.7	58.4	--	0.2	--	0.2
4. Basic Textiles and Leather Products	12 888	100.0	9.7	61.4	27.7	0.1	--	0.9	0.2
5. Apparel and Related Products	5 259	100.0	8.5	69.4	15.6	2.0	--	4.3	0.2
6. Paper and Allied Products	81 095	100.0	51.7	28.0	17.9	--	2.1	0.1	0.1
7. Basic Chemicals, Plastics Materials, Synthetic Resins, Rubber, and Fibers	101 451	100.0	48.6	30.1	12.1	--	8.6	0.4	0.2
8. Drugs, Paints, and Other Chemical Products	48 456	100.0	37.8	38.6	15.7	--	7.4	0.3	0.2
9. Petroleum and Coal Products	315 760	100.0	9.7	16.0	3.4	--	65.3	0.2	0.3
10. Rubber and Plastics Products	14 400	100.0	24.4	59.1	15.2	0.7	--	0.3	0.2
11. Lumber and Wood Products, Except Furniture	72 552	100.0	45.8	16.2	36.3	--	1.3	--	0.3
12. Furniture, Fixtures, and Miscellaneous Manufactured Products	13 034	100.0	22.0	41.4	34.7	0.3	0.2	1.2	0.2
13. Stone, Clay, and Glass Products	161 557	100.0	21.9	47.2	23.7	--	6.4	--	0.8
14. Primary Iron and Steel Products	126 491	100.0	43.7	44.4	6.7	--	4.8	0.3	0.1
15. Primary Nonferrous Metal Products	27 168	100.0	51.6	31.4	15.1	--	1.5	0.2	0.2
16. Fabricated Metal Products, Except Metal Cans and Miscellaneous Fabricated Metal Products	13 487	100.0	17.3	55.3	25.1	0.2	1.3	0.5	0.3
17. Metal Cans and Miscellaneous Fabricated Metal Products	21 491	100.0	36.8	44.1	17.8	0.3	0.3	0.4	0.3
18. Industrial Machinery, Except Electrical	7 890	100.0	19.6	59.4	18.9	0.6	0.1	1.2	0.1
19. Machinery, Except Electrical and Industrial	14 713	100.0	26.5	53.4	17.7	0.6	0.2	1.0	0.5
20. Communications Products and Parts	2 111	100.0	13.0	64.5	12.4	6.1	--	3.4	0.5
21. Electrical Products and Supplies	11 910	100.0	35.0	49.3	14.1	0.4	--	0.7	0.2
22. Motor Vehicles and Equipment	51 441	100.0	59.3	37.3	3.0	--	--	0.2	0.2
23. Transportation Equipment, Except Motor Vehicles	5 901	100.0	19.5	23.9	54.8	0.4	0.4	0.5	0.5
24. Instruments, Photographic Equipment, Watches, and Clocks	1 454	100.0	20.9	63.8	10.9	2.0	0.1	2.1	0.2

See footnotes at end of table.

TABLE 4-1. - Concluded

SHIPPER GROUP SUMMARY — PERCENT DISTRIBUTION BY MEANS OF TRANSPORT: 1972

Shipper Group	Tonne Kilometers	Means of Transport							
		All Means of Transport	Rail	Motor Carrier	Private Truck	Air	Water	Other	Unknown
	Millions	Percent Distribution							
Total Tonne Kilometers	919 927	100.0	42.0	20.9	6.8	0.2	29.6	0.2	0.3
1. Meat and Dairy Products	25 540	100.0	27.8	54.3	17.2	--	0.2	0.1	0.3
2. Canned and Frozen Foods and Other Food Products, Except Meat and Dairy Products	91 439	100.0	66.8	18.3	9.5	--	5.0	--	0.4
3. Candy, Cookies and Crackers, Beverages, and Tobacco Products[1]	20 992	100.0	43.1	28.8	25.8	--	1.9	--	0.3
4. Basic Textiles and Leather Products	9 735	100.0	16 3	61.0	21.0	0.2	--	1.2	0.4
5. Apparel and Related Products	4 586	100.0	13.4	67.0	9.5	4.8	0.1	5.0	0.2
6 Paper and Allied Products	59 116	100.0	73.8	18.9	5.6	--	1.3	--	0.2
7. Basic Chemicals, Plastics Materials, Synthetic Resins, Rubber, and Fibers	69 711	100.0	63.1	21.6	4.7	--	10.0	0.2	0.3
8. Drugs, Paints, and Other Chemical Products	32 916	100.0	44.3	32.0	8.4	0.1	14.4	0.4	0.3
9. Petroleum and Coal Products	280 403	100.0	7.9	3.4	1.6	--	87.0	--	0.1
10. Rubber and Plastics Products	11 869	100.0	32.1	56.8	9.3	1.0	0.3	0.3	0.2
11. Lumber and Wood Products, Except Furniture	64 402	100.0	76.8	7.6	10.7	--	4.7	--	0.2
12 Furniture, Fixtures, and Miscellaneous Manufactured Products	11 898	100.0	37.1	39.9	20.5	0.8	0.3	1.2	0.2
13. Stone, Clay, and Glass Products	49 916	100.0	45.3	36.6	11.3	--	6.1	--	0.6
14. Primary Iron and Steel Products	56 784	100.0	51.6	35.9	4.8	--	7.3	0.2	0.2
15. Primary Nonferrous Metal Products	23 928	100.0	67.2	23.4	7.7	--	1.1	0.2	0.3
16. Fabricated Metal Products, Except Metal Cans and Miscellaneous Fabricated Metal Products	10 666	100.0	23.3	60.1	13.0	0.4	2.1	0.6	0.5
17. Metal Cans and Miscellaneous Fabricated Metal Products	12 830	100.0	50.5	40.3	7.1	0.6	0.8	0.4	0.3
18. Industrial Machinery, Except Electrical	6 295	100.0	12.3	75.7	8.9	1.2	0.1	1.6	0.1
19. Machinery, Except Electrical and Industrial	14 175	100.0	37.7	49.7	8.9	1.3	0.6	1.2	0.5
20. Communications Products and Parts	2 104	100.0	18.0	59.9	5.6	12.0	0.3	3.3	0.9
21. Electrical Products and Supplies	10 954	100.0	43.2	46.0	8.4	0.8	0.5	1.0	0.3
22. Motor Vehicles and Equipment	44 145	100.0	80.9	17.4	1.0	0.1	0.2	0.2	0.3
23. Transportation Equipment, Except Motor Vehicles	3 809	100.0	24.0	30.3	43.1	1.3	0.3	0.8	0.3
24. Instruments, Photographic Equipment, Watches, and Clocks	1 725	100.0	34.4	53.9	5.7	3.6	0.3	1.9	0.2

[1] SIC 205 was out of scope to the 1967 survey. However, for the 1972 survey, SIC 2052, Cookies and Crackers, was included while SIC 2051 remained out of scope to the survey.

[2] Shipments excluded from the survey are those moving by pipeline (primarily petroleum products from refineries), parcel post shipments, and commodities moved by own power (motorized vehicles, aircraft, etc) or towed (prefabricated buildings, etc.). Local shipments (commodities shipped less than 25 miles from the plant) and shipments within the same city are also excluded. Shipments to Alaska and Hawaii from the 48 conterminous states and the District of Columbia are included; however, no data were obtained for shipments originating in Alaska and Hawaii.

[3] Distances of shipments to foreign designations are calculated only to the U.S. port of export.

TABLE 4-2

INTERCITY FREIGHT BY MODES[1]

Year	Rail Amount Tonne/Kilometer x 10^9	Truck Amount Tonne/Kilometer x 10^9	Air Amount Tonne/Kilometer x 10^9	Domestic Deep-Sea Amount Tonne/Kilometer x 10^9
1939	495	77	0.01	353
1940	553	90	0.03	368
1941	703	118	0.03	374
1942	941	88	0.06	140
1943	1073	83	0.07	96
1944	1090	85	0.10	102
1945	1008	98	0.13	187
1946	879	120	0.12	347
1947	970	149	0.16	317
1948	944	169	0.22	312
1949	781	185	0.29	323
1950	871	252	0.44	NA
1951	956	274	0.50	NA
1952	909	285	0.50	NA
1953	896	317	0.54	382
1954	813	311	0.55	NA
1955	921	325	0.72	381
1956	957	363	0.85	372
1957	914	371	0.99	362
1958	816	374	1.02	350
1959	849	407	1.17	385
1960	845	416	1.30	374
1961	832	432	1.47	369
1962	876	451	1.90	366
1963	918	490	1.90	356
1964	972	520	2.19	346

See footnotes at end of table.

TABLE 4-2. - Concluded

INTERCITY FREIGHT BY MODES[1]

Year	Rail Amount Tonne/Kilometer x 10^9	Truck Amount Tonne/Kilometer x 10^9	Air Amount Tonne/Kilometer x 10^9	Domestic Deep-Sea Amount Tonne/Kilometer x 10^9
1965	1035	524	2.79	331
1966	1096	556	3.28	328
1967	1067	568	3.78	339
1968	1105	578	4.23	331
1969	1130[2]	590	4.67	328
1970	1125	601	4.82	403
1971	1089	649	5.11	403
1972	1144	686	5.40	385
1973	1252	737	5.76	330
1974	1243	722	5.71	336
1975	1105	712	5.44	325

[1]Includes both For-Hire and Private Carriers, and Mail and Express
[2]Effective 1969 no longer includes mail and express

TABLE 4-3

REVENUE DISTRIBUTION AMONG REGULATED FREIGHT CARRIERS
(GROSS OPERATING REVENUE FROM TRANSPORTATION OF GOODS)

	Railroads Class I & II		Motor Carriers Class I, II and III		Water Carriers Class A, B and Maritime		Airways	
	$000	% of* Total	$000	% of Total	$000	% of Total	$000	% of Total
1940	$ 3 686 375	75.42	$ 867 000	17.74	$ 85 394	1.75	$ 23 000	0.47
1945	6 748 528	78.65	1 406 300	16.39	74 314	0.87	47 000	0.55
1950	7 933 800	63.69	3 737 052	30 00	259 111	2.08	86 000	0.69
1955	8 665 400	56.56	5 535 200	36.14	315 300	2.06	126 000	0.82
1960	8 151 700	48.91	7 213 900	43.28	328 300	1.97	203 727	1.22
1965	9 036 500	43.64	10 068 200	48 61	307 100	1.48	396 439	1.91
1970	11 124 100	39.76	14 584 800	52.14	365 000	1.30	713 423	2.55
1972	12 790 300	37.42	18 700 000	54.72	440 800	1.29	904 494	2.65
1973	14 003 300	37.05	20 800 000	55.02	510 300	1.35	1 038 458	2.75
1974	16 000 000	37.86	22 700 000	53.71	764 600	1.81	1 216 332	2.88
1975	15 636 000	37.66	22 000 000	53 00	765 100	1.84	1 295 098	3.12

*Balance of total is for other carriers not pertinent to this study.

TABLE 4-4

THE NATION'S ESTIMATED FREIGHT BILL

	Millions of Dollars										
	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Highway											
Truck-Intercity											
ICC-Regulated	10 068	10 862	11 308	12 715	13 944	14 585	16 700	18 700	20 800	22 700	21 000
Non-ICC Regulated	13 560	15 698	17 622	17 321	17 439	18 968	20 849	22 969	23 889	26 074	23 934
Truck - Local	23 041	22 929	24 507	27 852	30 429	35 531	41 622	50 333	57 722	58 763	64 620
Bus	70	75	84	97	108	122	125	132	137	144	156
	46 739	49 564	53 521	57 985	61 920	69 206	70 296	92 134	102 548	107 681	109 710
Rail											
Railroads	9 923	10 386	10 148	10 685	11 289	11 869	12 730	13 105	14 801	16 927	16 573
Water											
International	2 081	2 490	2 631	2 917	2 989	3 187	3 195	3 501	4 488	5 386	5 097
Coastal, Intercoastal	692	704	693	683	692	834	825	844	890	1 004	1 136
Inland Waterways	381	384	370	425	413	473	547	582	655	899	950
Great Lakes	213	227	210	210	237	239	222	243	286	340	348
Locks, Channels, etc.	391	393	401	373	350	376	385	417	436	512	526
	3 758	4 198	4 305	4 608	4 681	5 109	5 174	5 587	6 755	8 141	8 057
Oil Pipeline											
ICC-Regulated	904	941	995	1 023	1 103	1 188	1 249	1 338	1 446	1 587	1 881
Non-ICC Regulated	147	155	162	182	206	208	243	245	265	291	348
	1 051	1 096	1 157	1 205	1 309	1 396	1 492	1 583	1 711	1 878	2 229
Air											
Domestic	428	490	543	593	748	720	759	849	969	1 043	1 073
International	280	446	520	507	466	451	539	629	585	702	765
	708	939	1 063	1 100	1 214	1 171	1 298	1 478	1 554	1 745	1 838
Other Carriers											
Forwarders and REA Express	470	505	506	492	478	358	330	349	450	481	419
Other Shipper Costs											
Loading and Unloading Freight Cars	1 106	1 126	1 076	1 081	1 087	1 059	1 060	1 132	1 259	1 320	1 279
Operation of Traffic Departments	293	305	316	337	357	374	397	422	448	476	521
	1 399	1 431	1 392	1 418	1 444	1 443	1 457	1 554	1 707	1 796	1 800
GRAND TOTAL	64 048	68 116	72 092	77 493	82 335	90 542	101 777	115 790	129 526	138 649	140 626

TABLE 4-5

REVENUE BY MODE
1965 - 1975

	Rail	Truck	Air
	$/Tonne km		
1965	0.0096	0.0451	0.1534
1966	0.0095	0.0478	0.1494
1967	0.0095	0.0509	0.1437
1968	0.0097	0.0520	0.1402
1969	0.0100	0.0532	0.1602
1970	0.0106	0.0558	0.1494
1971	0.0117	0.0579	0.1485
1972	0.0115	0.0607	0.1572
1973	0.0118	0.0606	0.1682
1974	0.0136	0.0676	0.1827
1975	0.0150	0.0631	0.1972

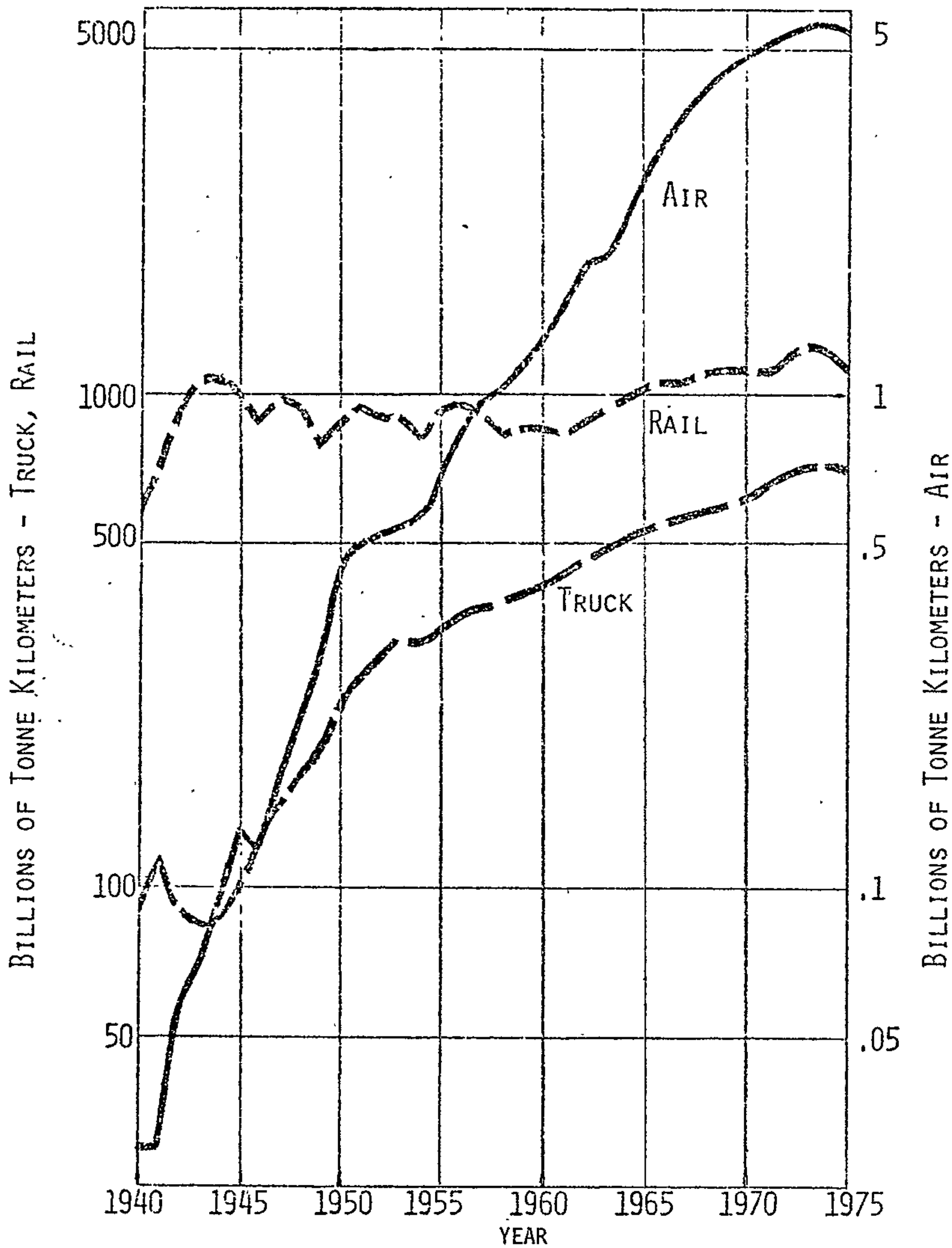


Figure 4-1. Volumes by Mode

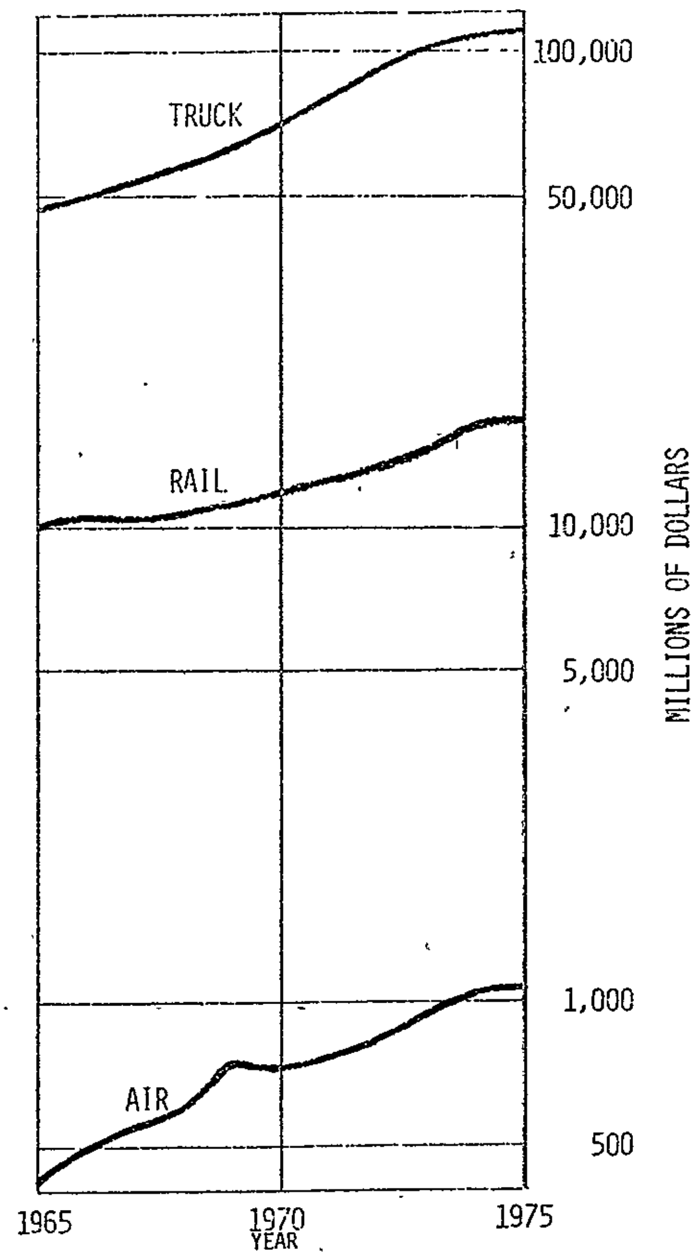


Figure 4-2. Intercity Freight Bill by Mode

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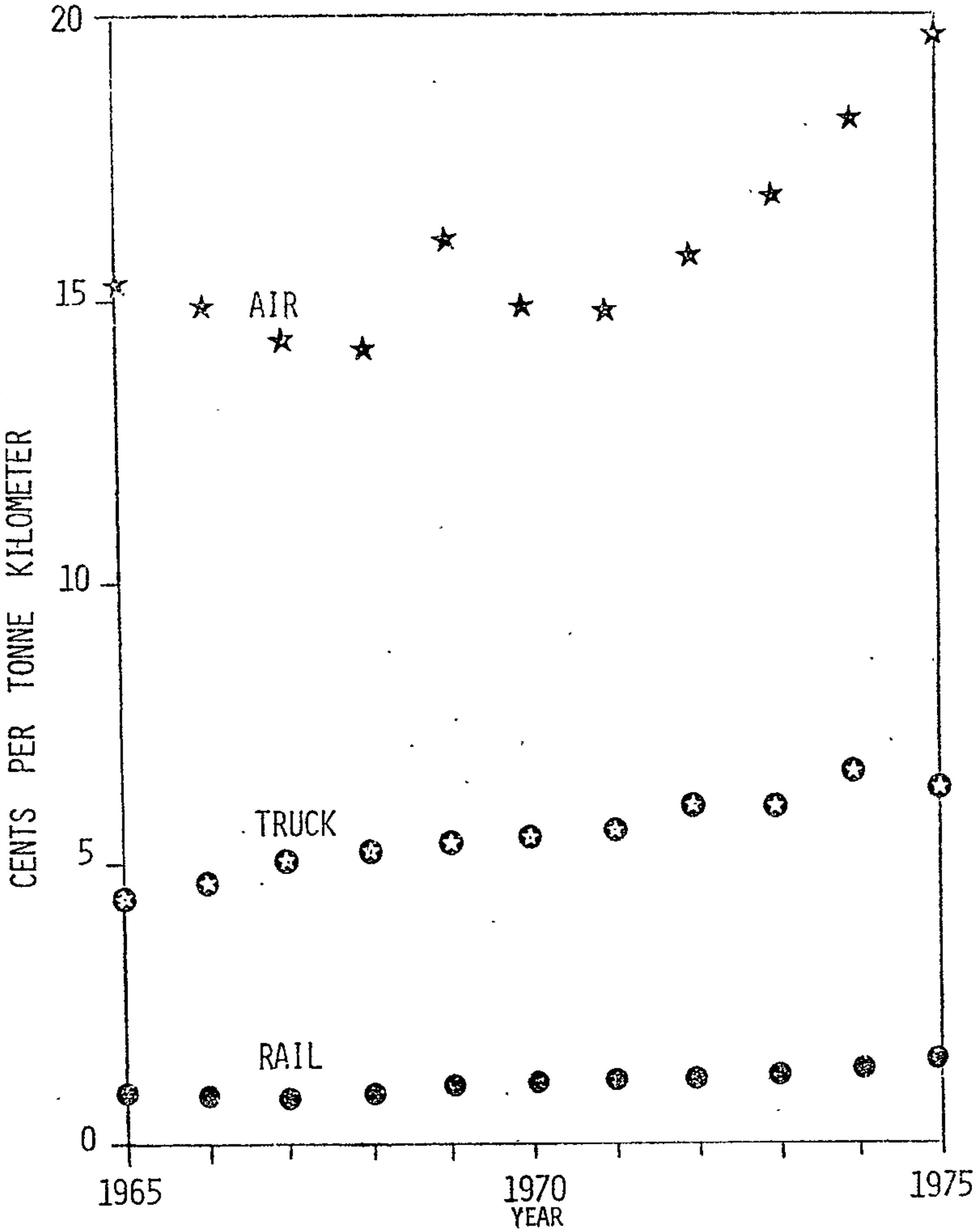

Figure 4-3. Revenue per Tonne-Kilometer

Modal Choice Selection Criteria

Modal choice is usually based on freight charges, time in transit, and service factors. Support for this classification is found in Figure 4-4 and Table 4-6, (Reference 4-2). Table 4-6 ranks modal choice selection criteria in order of importance. The Mean Importance Score is the average of all respondent ratings for each criterion out of a possible 100. Figure 4-4 illustrates the relative importance of the respective criterion. Consistent, on-time pickup and delivery stands out as the most important consideration.

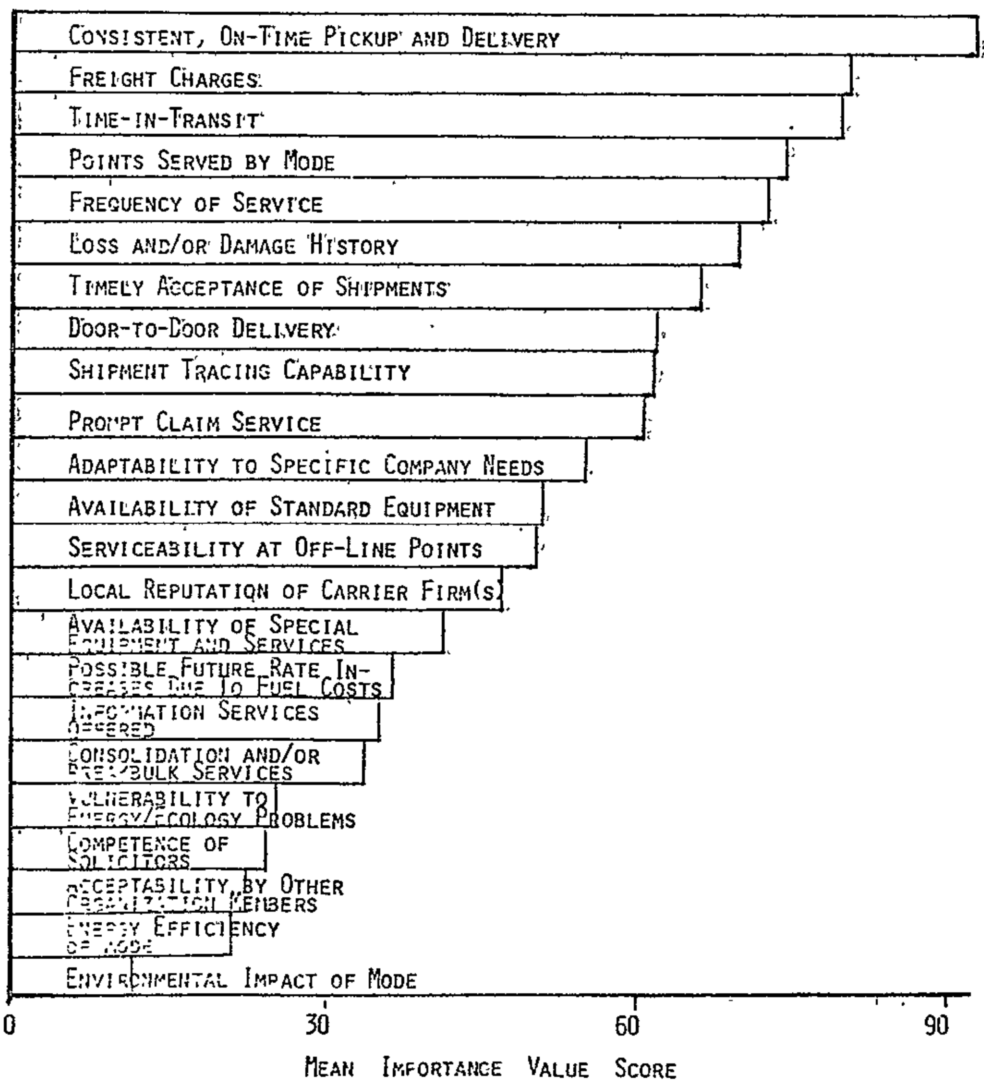

Figure 4-4. Selection Criteria Used to Evaluate Modal Choice

TABLE 4-6

MEAN IMPORTANCE VALUE SCORES FOR SELECTION CRITERIA USED TO EVALUATE MODAL CHOICES

Selection Criteria	Mean Importance Score
Consistent, On-Time Pickup and Delivery	92.4
Freight Charges	79.8
Time-in-Transit	79.1
Points Served by Mode, Including Routing Authority	73.9
Frequency of Service	72.1
Loss and/or Damage History	69.2
Timely Acceptance of Shipments of All Sizes	65.6
Door-to-Door Delivery	61.9
Shipment Tracing Capability	61.8
Prompt Claim Service	60.8
Adaptability to Specific Company Needs	55.5
Availability of Standard Equipment	50.6
Serviceability at Off-Line Points	50.2
Local Reputation of Carrier Firm(s)	47.1
Availability of Special Equipment and Services	41.0
Possible Future Rate Increases by Mode Due to Higher Fuel Costs	36.2
Information Services Offered	35.0
Consolidation and/or Breakbulk Services	33.9
Vulnerability of Mode to Current or Future Energy/Ecology Problems	25.1
Competence of Solicitors	24.5
Acceptability by Other Organization Members	22.6
Energy Efficiency (e.g., Fuel Economy) of Mode	21.1
Environmental Impact(s) of Mode	11.7

Note the groupings at lower levels which indicate little distinction in relative importance, as an example freight charges and time in-transit. In a like manner, door-to-door delivery, shipment racing capability, and prompt claim service are essentially considered to be of equal importance as are the availability of standard equipment and the serviceability of off-line points.

Current Tariff Structure

Due to the multiplicity of commodities, tariffs, routes, and shipment sizes, specific examples have been chosen to illustrate the current tariff structure by mode, Tables 4-7 through 4-28. Since one objective of this study is to determine the demand for airfreight, routes, shipment sizes, and commodities, relevant to airfreight industry, the considered routes include Los Angeles to/from New York, Chicago to/from New York, San Francisco to/from New York, Los Angeles to/from Chicago, San Francisco to/from Chicago. The international routes analyzed include Los Angeles to/from Tokyo, Los Angeles to/from Jakarta, New York to/from Rio de Janeiro, New York to/from London, and Tokyo to/from Frankfurt. Weight breaks of 45, 225, 455, 2270, 4540, 9080, and 18 160 kilograms are considered. The commodities analyzed include fresh vegetables, medicine, power machinery, computers, electrical machinery, and clothing, with respective tariffs developed for each of the applicable modes.

Several explanations concerning the data presented in Table 4-7 are necessary. To facilitate mode comparisons, the domestic air and rail tariffs are shown not only in cents per kilogram but also as a percent of truck tariffs. In a similar manner, international air tariffs are presented as a percent of ocean tariffs. The stated tariffs are those charged directly by each mode to shippers. Charges for freight-forwarder services are not included. Air and truck tariffs are specific for the weights given, but rail tariffs, due to the rail tariff structure, are based on a minimum size shipment and any smaller size shipment must pay the same total charge. When air tariffs are based on general commodity rates (GCR), it is so noted. On international routes, the air and ocean tariffs exclude pickup and delivery, tax surcharges, bunker charges, Panama Canal charges, and customs duties (i.e., they include only line-haul charges). For fresh vegetables, there is an additional fixed charge for rail shipment refrigeration that is included.

Several relevant observations can be drawn from the domestic data presented in Tables 4-7 through 4-16:

- Truck is the least costly means of transport for small shipments in 146 of the 150 cases considered.
- For large shipments, 980 kg or more, truck is the least costly means of transport in 39 of 60 cases and rail is the least costly in the remaining 21 cases.
- The weight breaks at which transportation tariffs show significant declines vary with mode. As an example, these breaks occur at 225, 445, and 2270 kg for air; at 225 and at 9080 kg or higher for truck; and at 4540 kg or higher for rail.
- In general, air rates, as a percentage of truck rates, increase slightly in the 45-to 225-kg range, fall in the 225-to 455-kg range, remain relatively constant in the 455 to 4540 range, and increase appreciably for the 4540-kg and above weights. However, as can be seen from the behavior presented in Figure 4-5, a graphical presentation of two commodity classes on the New York to Los Angeles route, the general relationships do not always hold.
- Rail tariffs as a percentage of truck tariffs fall significantly as the size of the shipment increases due to the fact that rail rates are based on a minimum shipment size, usually 9080 kg or higher. This is illustrated by the example presented in Figure 4-5.
- Significant west-to-east airfreight directional tariff discounts exist for vegetables, medicine, power generating machinery, electrical machinery, and clothing.

Three relevant observations can be drawn from the international data presented in Table 4-17 through 4-28:

- For small shipments, 45 kilograms, there are many instances, origin-destinations and commodities, where air tariffs are less than sea tariffs. However, within the 500 cases investigated it was found that air tariffs on clothing between Rio de Janiero and New York varied between 21 to 44 percent of sea tariffs over the full range of weight breaks.

TABLE 4-7

CURRENT TARIFF STRUCTURE
ROUTE: CHICAGO TO NEW YORK CITY

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	10 900 or greater*
Fresh Vegetables							
Air GCR ¢/kg	97.75	90.58	76.04	59.40	56.97	55.32	55.32
Truck GCR ¢/kg	43.20	27.42	23.78	17.39	16.53	15.67	6.63 (10 900#)
Rail GCR ¢/kg	-	-	-	66.74	33.37	16.68	16.68
Air/Rail % of Truck	226	330	320	342/384	345/202	353/106	834/251 (10 900#)
Medicine							
Air GCR ¢/kg	97.75	90.58	76.04	59.40	56.97	55.32	55.32
Truck GCR ¢/kg	43.20	23.52	20.43	14.57	13.86	7.93	7.93
Rail GCR ¢/kg	-	-	-	37.03	18.51	9.26	6.17 (13 620#)
Air/Rail % of Truck	226	385	372	408/254	411/134	697/117	697/78 (13 620#)
Power Machinery							
Air GCR ¢/kg	97.75	90.58	76.04	59.40	56.97	55.32	55.32
Truck GCR ¢/kg	43.20	23.52	20.43	14.57	13.86	7.93	7.93
Rail GCR ¢/kg	-	-	-	40.11	20.06	10.03	8.35 (10 900#)
Air/Rail % of Truck	226	385	372	408/275	411/145	697/126	697/105 (10 900#)
Computers							
Air GCR ¢/kg	97.75	90.58	76.04	59.40	56.97	55.32	55.32
Truck GCR ¢/kg	43.20	27.42	23.78	17.39	16.53	15.67	12.32 (10 900#)
Rail GCR ¢/kg	-	-	-	52.81	26.40	13.2	8.79 (13 620#)
Air/Rail % of Truck	226	330	320	342/304	345/160	353/84	449/71 (13 620#)
Electric Machinery							
Air GCR ¢/kg	97.75	90.58	76.04	59.40	56.97	55.32	55.32
Truck GCR ¢/kg	43.20	19.57	17.06	12.17	11.53	10.95	7.12 (10 900#)
Rail GCR ¢/kg	-	-	-	37.03	18.51	9.26	6.17 (13 620#)
Air/Rail % of Truck	226	463	446	488/304	494/161	505/85	777/87 (13 620#)
Clothing							
Air GCR ¢/kg	97.75	90.58	76.04	59.40	46.97	55.32	55.32
Truck GCR ¢/kg	43.20	27.42	23.78	17.39	16.53	14.90	14.90
Rail GCR ¢/kg	-	-	-	33.10	16.55	16.55	9.50 (10 900#)
Air/Rail % of Truck	226	330	320	342/190	345/100	371/111	371/64 (10 900#)

*Minimum applicable weight is expressed parenthetically.

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TABLE 4-8

CURRENT TARIFF STRUCTURE
ROUTE: NEW YORK CITY TO CHICAGO

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	10 900 or greater*
Fresh Vegetables							
Air GCR ¢/kg	97.75	90.58	76.04	59.40	56.97	55.32	55.32
Truck GCR ¢/kg	43.26	27.42	23.78	17.39	16.53	15.67	6.63 (10 900#)
Rail GCR ¢/kg	-	-	-	66.74	33.37	16.68	16.68
Air/Rail % of Truck	226	330	320	342/384	345/202	353/106	834/251 (10 900#)
Medicine							
Air GCR ¢/kg	97.75	90.58	76.04	59.40	56.97	55.32	55.32
Truck GCR ¢/kg	43.20	23.52	20.43	14.57	13.86	7.93	7.93
Rail GCR ¢/kg	-	-	-	37.03	18.51	9.26	6.17 (13 620#)
Air/Rail % of Truck	226	385	372	408/254	411/134	697/117	697/78 (13 620#)
Power Machinery							
Air GCR ¢/kg	97.75	90.58	76.04	59.40	56.97	55.32	55.32
Truck GCR ¢/kg	43.20	23.52	20.43	14.57	13.86	7.93	7.93
Rail GCR ¢/kg	-	-	-	40.11	20.06	10.03	8.35 (10 900#)
Air/Rail % of Truck	226	385	372	408/275	411/145	697/126	697/105 (10 900#)
Computers							
Air GCR ¢/kg	97.75	90.58	76.04	59.40	56.97	55.32	55.32
Truck GCR ¢/kg	43.20	27.42	23.78	17.39	16.53	15.67	12.32 (10 900#)
Rail GCR ¢/kg	-	-	-	52.81	26.40	13.20	8.79 (13 620#)
Air/Rail % of Truck	226	330	320	342/304	345/160	353/84	449/71 (13 620#)
Electric Machinery							
Air GCR ¢/kg	97.75	90.58	76.04	59.40	56.97	55.32	55.32
Truck GCR ¢/kg	43.20	19.57	17.06	12.17	11.53	10.95	7.12 (10 900#)
Rail GCR ¢/kg	-	-	-	37.03	18.51	9.26	6.17 (13 620#)
Air/Rail % of Truck	226	463	446	488/304	494/161	505/85	777/87 (13 620#)
Clothing							
Air GCR ¢/kg	97.75	90.58	76.04	59.40	56.97	55.32	55.32
Truck GCR ¢/kg	43.20	27.42	23.78	17.39	16.53	14.90	14.90
Rail GCR ¢/kg	-	-	-	33.10	16.55	16.55	9.50 (10 900#)
Air/Rail % of Truck	226	330	320	342/190	345/100	371/111	371/64 (10 900#)

*Minimum applicable weight is expressed parenthetically.

TABLE 4-9

CURRENT TARIFF STRUCTURE
ROUTE: CHICAGO TO SAN FRANCISCO

Commodity	Weight in kilograms 45	225	455	2270	4540	9080	>9 080 (up to 18 160#)
Fresh Vegetables							
Air GCR ¢/kg	107.11	107.11	92.02	83.31	81.44	81.22	81.22
Truck GCR ¢/kg	50.78	46.75	42.03	34.03	33.32	20.39	20.39
Rail GCR ¢/kg	-	-	-	54.13	27.07	13.53	13.53
Air/Rail % of Truck	211	229	219	245/159	244/81	398/66	398/66
Medicine							
Air GCR ¢/kg	107.11	107.11	92.02	83.31	81.44	81.22	81.22
Truck GCR ¢/kg	43.15	39.74	35.73	28.92	28.32	27.79	17.04 (10 900#)
Rail GCR ¢/kg	-	-	-	116.02	58.01	29.01	24.18 (10 900#)
Air/Rail % of Truck	248	270	258	288/401	288/205	292/104	477/142 (10 900#)
Power Machinery							
Air GCR ¢/kg	107.11	107.11	92.02	83.31	81.44	81.22	81.22
Truck GCR ¢/kg	43.15	29.07	26.14	21.80	21.80	16.77	16.07 (10 900#)
Rail GCR ¢/kg	-	-	-	117.87	58.94	29.47	19.64 (13 620#)
Air/Rail % of Truck	248	368	352	382/541	374/270	484/176	505/122 (13 620#)
Computers							
Air GCR ¢/kg	107.11	107.11	92.02	83.31	81.44	81.22	81.22
Truck GCR ¢/kg	50.78	29.07	26.14	21.80	21.80	16.66	16.66
Rail GCR ¢/kg	-	-	-	143.35	71.67	35.84	23.89 (15 890#)
Air/Rail % of Truck	211	368	352	382/658	374/329	487/215	487/143 (15 890#)
Electric Machinery							
Air GCR ¢/kg	107.11	107.11	92.02	83.31	81.44	81.22	81.22
Truck GCR ¢/kg	39.36	25.68	23.14	19.29	19.29	19.29	16.07 (10 900#)
Rail GCR ¢/kg	-	-	-	119.55	59.77	29.89	14.94 (18 160#)
Air/Rail % of Truck	272	417	398	432/620	622/310	421/155	505/93 (18 160#)
Clothing							
Air GCR ¢/kg	107.11	107.11	79.90	71.41	69.54	69.32	69.32
Truck GCR ¢/kg	50.78	37.69	33.90	28.30	28.30	28.30	28.30
Rail GCR ¢/kg	-	-	-	101.38	50.69	33.79	33.79
Air/Rail % of Truck	211	284	236	252/358	246/179	245/119	245/119

*Minimum applicable weight is expressed parenthetically.

TABLE 4-10

CURRENT TARIFF STRUCTURE
ROUTE: SAN FRANCISCO TO CHICAGO

Commodity	Weight in kilograms 45	225	455	2270	4540	9080	>9 080 (up to 18 160#)
Fresh Vegetables							
Air GCR ¢/kg	105.79	73.94	62.81	42.65	40.77	40.55	40.55
Truck GCR ¢/kg	50.78	46.75	42.03	34.03	33.32	20.39	20.39
Rail GCR ¢/kg	-	-	-	96.45	48.72	24.11	12.06 (18 160#)
Air/Rail % of Truck	208	158	149	125/283	122/145	199/118	199/59 (18 160#)
Medicine							
Air GCR ¢/kg	105.79	95.43	89.15	73.94	72.07	71.85	71.85
Truck GCR ¢/kg	43.15	39.74	35.73	28.92	28.32	28.32	17.04 (10 900#)
Rail GCR ¢/kg	-	-	-	116.02	58.01	29.01	24.18 (10 900#)
Air/Rail % of Truck	245	240	250	256/401	254/205	254/102	422/142 (10 900#)
Power Machinery							
Air GCR ¢/kg	105.79	95.43	89.15	73.94	72.07	71.85	71.85
Truck GCR ¢/kg	43.15	24.51	22.04	18.38	18.38	18.38	16.07 (10 900#)
Rail GCR ¢/kg	-	-	-	104.38	52.19	26.10	21.75 (10 900#)
Air/Rail % of Truck	245	389	404	402/568	392/284	391/142	447/135 (10 900#)
Computers							
Air GCR ¢/kg	105.79	89.26	80.12	64.03	62.15	61.93	61.93
Truck GCR ¢/kg	50.78	46.75	41.94	34.03	33.32	33.32	15.21 (15 890#)
Rail GCR ¢/kg	-	-	-	143.35	71.67	35.84	23.89 (13 620#)
Air/Rail % of Truck	208	191	191	188/421	187/215	186/108	407/157 (15 890#)
Electric Machinery							
Air GCR ¢/kg	105.79	95.43	89.15	73.94	72.07	71.85	71.85
Truck GCR ¢/kg	39.36	25.83	23.21	19.33	19.33	19.33	16.07 (10 900#)
Rail GCR ¢/kg	-	-	-	117.61	58.80	29.40	14.70 (18 160#)
Air/Rail % of Truck	268	369	384	383/608	373/304	372/152	447/91 (18 160#)
Clothing							
Air GCR ¢/kg	105.79	88.82	81.99	68.43	66.56	66.34	66.34
Truck GCR ¢/kg	50.78	37.84	34.05	28.43	28.43	12.92	12.92
Rail GCR ¢/kg	-	-	-	101.38	50.69	33.79	33.79
Air/Rail % of Truck	208	235	241	241/357	284/178	514/262	514/262

*Minimum applicable weight is expressed parenthetically.

TABLE 4-11

CURRENT TARIFF STRUCTURE
ROUTE: CHICAGO TO LOS ANGELES

Commodity	Weight in kilograms						
	45	225	455	2270	4540	9080	>9 080 (up to 18 160#)
Fresh Vegetables							
Air GCR ¢/kg	81.66	78.66	69.76	60.17	58.74	57.75	57.75
Truck GCR ¢/kg	50.78	46.75	42.03	34.03	33.32	20.39	20.39
Rail GCR ¢/kg	-	-	-	54.13	27.07	13.53	13.53
Air/Rail % of Truck	161	168	166	177/159	176/81	283/66	283/66
Medicine							
Air GCR ¢/kg	81.66	78.68	69.76	60.17	58.74	57.75	57.75
Truck GCR ¢/kg	43.15	39.74	35.73	28.92	28.32	27.79	17.04 (10 900#)
Rail GCR ¢/kg	-	-	-	116.02	58.01	29.01	24.18 (10 900#)
Air/Rail % of Truck	189	198	195	208/401	207/205	208/104	339/142 (10 900#)
Power Machinery							
Air GCR ¢/kg	81.66	78.68	69.76	60.17	58.74	57.75	57.75
Truck GCR ¢/kg	43.15	29.07	26.14	21.80	21.80	16.77	16.07 (10 900#)
Rail GCR ¢/kg	-	-	-	117.87	58.94	29.47	19.64 (13 620#)
Air/Rail % of Truck	189	271	267	276/541	269/270	344/176	359/122 (13 620#)
Computers							
Air GCR ¢/kg	81.66	78.68	69.76	60.17	58.74	57.75	57.75
Truck GCR ¢/kg	50.78	29.07	26.14	21.80	21.80	16.66	16.66
Rail GCR ¢/kg	-	-	-	143.35	71.67	35.84	23.89 (13 620#)
Air/Rail % of Truck	161	271	267	276/658	269/329	347/215	347/143 (13 620#)
Electric Machinery							
Air GCR ¢/kg	81.66	78.68	69.76	60.17	58.74	57.75	57.75
Truck GCR ¢/kg	39.36	25.68	23.14	19.29	19.29	19.29	16.07 (10 900#)
Rail GCR ¢/kg	-	-	-	119.55	59.77	29.89	14.94 (18 160#)
Air/Rail % of Truck	207	306	301	312/620	305/310	299/155	359/93 (18 160#)
Clothing							
Air GCR ¢/kg	81.66	78.68	60.72	51.79	50.36	49.37	49.37
Truck GCR ¢/kg	50.78	37.84	33.90	28.30	28.30	28.30	28.30
Rail GCR ¢/kg	-	-	-	101.38	50.69	33.79	33.79
Air/Rail % of Truck	161	209	179	183/358	178/179	174/119	174/119

*Minimum applicable weight is expressed parenthetically.

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TABLE 4-12

CURRENT TARIFF STRUCTURE
ROUTE: LOS ANGELES TO CHICAGO

Commodity	Weight in kilograms						
	45	225	455	2270	4540	9080	>9 080 (up to 18 160#)
Fresh Vegetables							
Air GCR ¢/kg	79.45	67.66	61.16	38.13	36.70	35.71	35.71
Truck GCR ¢/kg	50.78	46.75	42.03	34.03	33.32	20.39	20.39
Rail GCR ¢/kg	-	-	-	96.45	48.72	24.11	12.06 (18 160#)
Air/Rail % of Truck	157	145	146	112/283	110/145	175/118	175/59 (18 160#)
Medicine							
Air GCR ¢/kg	79.05	67.66	61.16	48.05	46.62	45.62	45.62
Truck GCR ¢/kg	43.15	39.74	35.73	28.92	28.32	28.32	17.04 (10 900#)
Rail GCR ¢/kg	-	-	-	116.02	58.01	29.01	24.18 (10 900#)
Air/Rail % of Truck	184	170	171	162/401	165/205	161/102	268/142 (10 900#)
Power Machinery							
Air GCR ¢/kg	79.05	59.84	52.13	43.31	41.88	40.88	40.88
Truck GCR ¢/kg	43.15	24.51	22.04	18.38	18.38	18.38	16.07 (10 900#)
Rail GCR ¢/kg	-	-	-	104.38	52.19	26.10	21.75 (10 900#)
Air/Rail % of Truck	184	244	237	236/568	228/284	222/142	254/135 (10 900#)
Computers							
Air GCR ¢/kg	79.05	59.84	52.13	43.31	41.88	40.88	40.88
Truck GCR ¢/kg	50.78	46.75	41.94	34.03	33.32	33.32	15.21 (15 890#)
Rail GCR ¢/kg	-	-	-	143.35	71.67	35.84	23.84 (13 620#)
Air/Rail % of Truck	156	128	124	127/421	126/215	123/108	269/157 (15 890#)
Electric Machinery							
Air GCR ¢/kg	79.05	59.84	52.13	43.31	41.88	40.88	40.88
Truck GCR ¢/kg	39.36	25.83	23.21	19.33	19.33	19.33	16.07 (10 900#)
Rail GCR ¢/kg	-	-	-	117.61	58.80	29.40	14.70 (18 160#)
Air/Rail % of Truck	202	232	225	224/608	217/304	212/152	254/91 (18 160#)
Clothing							
Air GCR ¢/kg	54.44	51.24	46.84	40.77	39.34	38.35	38.35
Truck GCR ¢/kg	50.78	37.84	34.05	28.43	28.43	18.07	18.07
Rail GCR ¢/kg	-	-	-	101.38	50.69	33.79	33.79
Air/Rail % of Truck	156	135	138	143/357	138/178	212/187	212/187

*Minimum applicable weight is expressed parenthetically.

TABLE 4-13

CURRENT TARIFF STRUCTURE
ROUTE: SAN FRANCISCO TO NEW YORK CITY

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9 080 (up to 18 160#)
Fresh Vegetables							
Air GCR ¢/kg	133.12	133.12	80.23	51.46	48.71	47.28	47.28
Truck GCR ¢/kg	60.90	56.07	50.45	40.80	39.98	24.46	24.46
Rail GCR ¢/kg	-	-	-	126.33	63.17	31.58	15.80 (18 160#)
Air/Rail % of Truck	219	186	159	126/310	122/158	193/129	193/65 (18 160#)
Medicine							
Air GCR ¢/kg	133.12	122.10	112.85	59.18	56.42	54.99	54.99
Truck GCR ¢/kg	51.77	47.65	42.89	34.67	33.99	33.28	20.43 (10 900#)
Rail GCR ¢/kg	-	-	-	139.12	69.56	34.78	28.98 (10 900#)
Air/Rail % of Truck	257	256	263	171/401	166/205	162/102	269/142 (10 900#)
Power Machinery							
Air GCR ¢/kg	133.12	100.17	87.17	73.83	71.08	69.65	69.65
Truck GCR ¢/kg	51.77	39.36	35.42	29.56	29.56	29.56	19.31 (10 900#)
Rail GCR ¢/kg	-	-	-	125.28	62.64	31.32	26.10 (10 900#)
Air/Rail % of Truck	257	254	246	250/424	240/212	236/106	361/135 (10 900#)
Computers							
Air GCR ¢/kg	133.12	116.59	88.49	77.58	74.83	73.39	73.39
Truck GCR ¢/kg	60.90	42.58	38.31	31.98	31.98	31.98	28.56 (10 900#)
Rail GCR ¢/kg	-	-	-	172.97	86.49	43.24	28.83 (13 620#)
Air/Rail % of Truck	219	274	231	243/541	234/270	229/135	257/101 (13 620#)
Electric Machinery							
Air GCR ¢/kg	133.12	122.10	112.85	100.72	95.76	94.33	94.33
Truck GCR ¢/kg	47.19	38.68	34.89	29.05	29.05	29.05	19.31 (10 900#)
Rail GCR ¢/kg	-	-	-	138.15	74.58	37.29	18.65 (18 160#)
Air/Rail % of Truck	282	316	323	347/476	330/238	325/119	489/97 (18 160#)
Clothing							
Air GCR ¢/kg	133.12	116.70	104.03	85.52	82.76	81.33	81.33
Truck GCR ¢/kg	60.90	44.41	39.94	33.37	33.37	33.37	79.96 (14 530#)
Rail GCR ¢/kg	-	-	-	121.88	60.94	40.62	40.62
Air/Rail % of Truck	192	263	247	256/365	248/183	235/117	453/226 (14 530#)

*Minimum applicable weight is expressed parenthetically.

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TABLE 4-14

CURRENT TARIFF STRUCTURE
ROUTE: NEW YORK CITY TO SAN FRANCISCO

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9 080 (up to 18 160)*
Fresh Vegetables							
Air GCR ¢/kg	133.12	133.12	112.85	101.94	99.18	97.75	97.75
Truck GCR ¢/kg	60.90	56.07	50.45	40.80	39.98	24.46	24.46
Rail GCR ¢/kg	-	-	-	112.76	56.38	28.19	28.19
Air/Rail % of Truck	219	237	224	250/276	248/138	400/115	400/115
Medicine							
Air GCR ¢/kg	133.12	133.12	62.26	52.57	49.81	48.38	48.38
Truck GCR ¢/kg	51.77	47.65	42.89	34.67	33.99	33.28	20.43 (10 900#)
Rail GCR ¢/kg	-	-	-	139.12	69.56	34.78	28.98 (10 900#)
Air/Rail % of Truck	257	279	145	152/401	147/205	145/105	237/142 (10 900#)
Power Machinery							
Air GCR ¢/kg	133.12	133.12	112.85	101.94	99.18	97.75	97.75
Truck GCR ¢/kg	51.77	36.79	33.06	27.62	27.62	27.62	19.31 (10 900#)
Rail GCR ¢/kg	-	-	-	124.75	62.37	31.19	20.78 (13 620#)
Air/Rail % of Truck	257	362	341	369/452	369/226	354/113	506/108 (13 620#)
Computers							
Air GCR ¢/kg	133.12	133.12	112.85	101.94	99.18	97.75	97.75
Truck GCR ¢/kg	60.90	35.07	31.52	26.27	26.27	26.27	22.50 (10 900#)
Rail GCR ¢/kg	-	-	-	172.97	86.49	43.24	28.83 (13 620#)
Air/Rail % of Truck	219	380	358	388/658	378/329	372/165	434/128 (13 620#)
Electric Machinery							
Air GCR ¢/kg	133.12	133.12	112.85	101.94	99.18	97.75	97.75
Truck GCR ¢/kg	47.19	33.52	30.13	25.13	25.13	25.13	19.31 (10 900#)
Rail GCR ¢/kg	-	-	-	137.88	68.94	34.47	17.24 (18 160#)
Air/Rail % of Truck	282	397	375	406/549	395/274	389/137	506/89 (18 160#)
Clothing							
Air GCR ¢/kg	117.14	117.14	98.52	87.50	84.74	83.31	83.31
Truck GCR ¢/kg	60.90	44.41	39.94	33.37	33.37	33.37	33.37
Rail GCR ¢/kg	-	-	-	121.88	60.94	40.62	40.62
Air/Rail % of Truck	192	264	247	262/365	254/183	250/122	250/122

*Minimum applicable weight is expressed parenthetically.

TABLE 4-15

CURRENT TARIFF STRUCTURE
ROUTE: NEW YORK CITY TO LOS ANGELES

Commodity	Weight in Kilograms 45	225	455	2270	4540	9080	>9080 (up to 18 160#)*
Fresh Vegetables							
Air GCR ¢/kg	129.27	129:27	108.22	98.63	96.32	94.11	94.11
Truck GCR ¢/kg	60.90	56.07	50.45	40.80	39.98	24.46	24.46
Rail GCR ¢/kg	-	-	-	112.76	56.38	28.19	28.19
Air/Rail % of Truck	212	198	215	242/276	241/141	385/115	385/115
Medicine							
Air GCR ¢/kg	129.27	129.27	59.07	50.69	48.38	46.17	46.17
Truck GCR ¢/kg	51.77	47.65	42.89	34.67	33.99	33.28	20.43 (10 900#)
Rail GCR ¢/kg	-	-	-	139.12	69.56	34.78	28.98 (10 900#)
Air/Rail % of Truck	250	256	138	146/401	142/205	139/105	226/142 (10 900#)
Power Machinery							
Air GCR ¢/kg	129.27	129.27	108.22	98.63	96.32	94.11	94.11
Truck GCR ¢/kg	51.77	34.27	30.83	25.72	25.72	25.72	19.31 (10 900#)
Rail GCR ¢/kg	-	-	-	124.75	62.37	31.18	20.78 (13 620#)
Air/Rail % of Truck	250	377	351	383/485	374/243	366/121	487/188 (13 620#)
Computers							
Air GCR ¢/kg	129.27	129.27	80.56	66.12	63.81	61.60	61.60
Truck GCR ¢/kg	60.90	35.07	31.52	26.27	26.27	26.27	22.50 (10 900#)
Rail GCR ¢/kg	-	-	-	172.97	86.49	43.24	28.83 (13 620#)
Air/Rail % of Truck	212	369	256	252/658	253/329	234/165	274/128 (13 620#)
Electric Machinery							
Air GCR ¢/kg	129.27	129.27	108.22	98.63	96.32	94.11	94.11
Truck GCR ¢/kg	47.19	33.52	30.13	25.13	25.13	25.13	19.31 (10 900#)
Rail GCR ¢/kg	-	-	-	137.88	68.94	34.47	17.24 (18 160#)
Air/Rail % of Truck	274	386	359	393/549	383/274	375/137	487/89 (18 160#)
Clothing							
Air GCR ¢/kg	113.40	113.40	94.22	84.52	82.21	80.01	80.01
Truck GCR ¢/kg	60.90	44.41	39.94	33.37	33.37	33.37	33.37
Rail GCR ¢/kg	-	-	-	121.88	60.94	40.62	40.62
Air/Rail % of Truck	186	255	236	253/365	246/183	240/122	240/122

*Minimum applicable weight is expressed parenthetically.

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TABLE 4-16

CURRENT TARIFF STRUCTURE
ROUTE: LOS ANGELES TO NEW YORK CITY

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)*
Fresh Vegetables							
Air GCR ¢/kg	129.27	111.08	71.41	56.64	54.33	52.13	52.13
Truck GCR ¢/kg	60.90	56.07	50.45	40.80	39.98	24.46	24.46
Rail GCR ¢/kg	-	-	-	126.33	63.17	31.58	15.80 (18 160#)
Air/Rail % of Truck	212	198	142	139/310	136/158	213/129	213/65 (18 160#)
Medicine							
Air GCR ¢/kg	129.27	122.10	108.22	98.63	96.32	94.11	94.11
Truck GCR ¢/kg	51.77	47.65	42.89	34.67	33.99	33.99	20.43 (10 900#)
Rail GCR ¢/kg	-	-	-	139.12	69.56	34.78	28.98 (18 160#)
Air/Rail % of Truck	250	256	252	284/401	283/205	277/102	461/142 (18 160#)
Power Machinery							
Air GCR ¢/kg	129.27	94.66	81.33	70.42	68.10	65.90	65.90
Truck GCR ¢/kg	51.77	39.36	35.42	29.56	29.56	29.56	19.31 (10 900#)
Rail GCR ¢/kg	-	-	-	125.28	62.64	31.32	26.10 (10 900#)
Air/Rail % of Truck	250	240	230	238/424	230/212	223/106	341/135 (10 900#)
Computers							
Air GCR ¢/kg	129.27	94.66	81.33	70.42	68.10	65.90	65.90
Truck GCR ¢/kg	60.90	42.58	38.31	31.98	31.98	31.98	28.56 (10 900#)
Rail GCR ¢/kg	-	-	-	172.97	86.49	43.24	28.83 (13 620#)
Air/Rail % of Truck	212	222	212	220/541	213/270	206/135	231/101 (13 620#)
Electric Machinery							
Air GCR ¢/kg	129.27	89.70	76.26	65.35	63.03	60.83	60.83
Truck GCR ¢/kg	47.19	38.68	34.89	29.05	29.05	29.05	19.31 (10 900#)
Rail GCR ¢/kg	-	-	-	149.17	74.58	37.29	18.65 (18 160#)
Air/Rail % of Truck	274	232	219	225/476	217/238	209/119	315/97 (18 160#)
Clothing							
Air GCR ¢/kg	119.46	111.74	98.08	76.04	73.72	71.52	71.52
Truck GCR ¢/kg	60.90	44.41	39.94	33.37	33.37	21.67	21.67
Rail GCR ¢/kg	-	-	-	121.88	60.94	40.62	40.62
Air/Rail % of Truck	212	252	246	228/365	221/183	330/187	330/187

*Minimum applicable weight is expressed parenthetically.

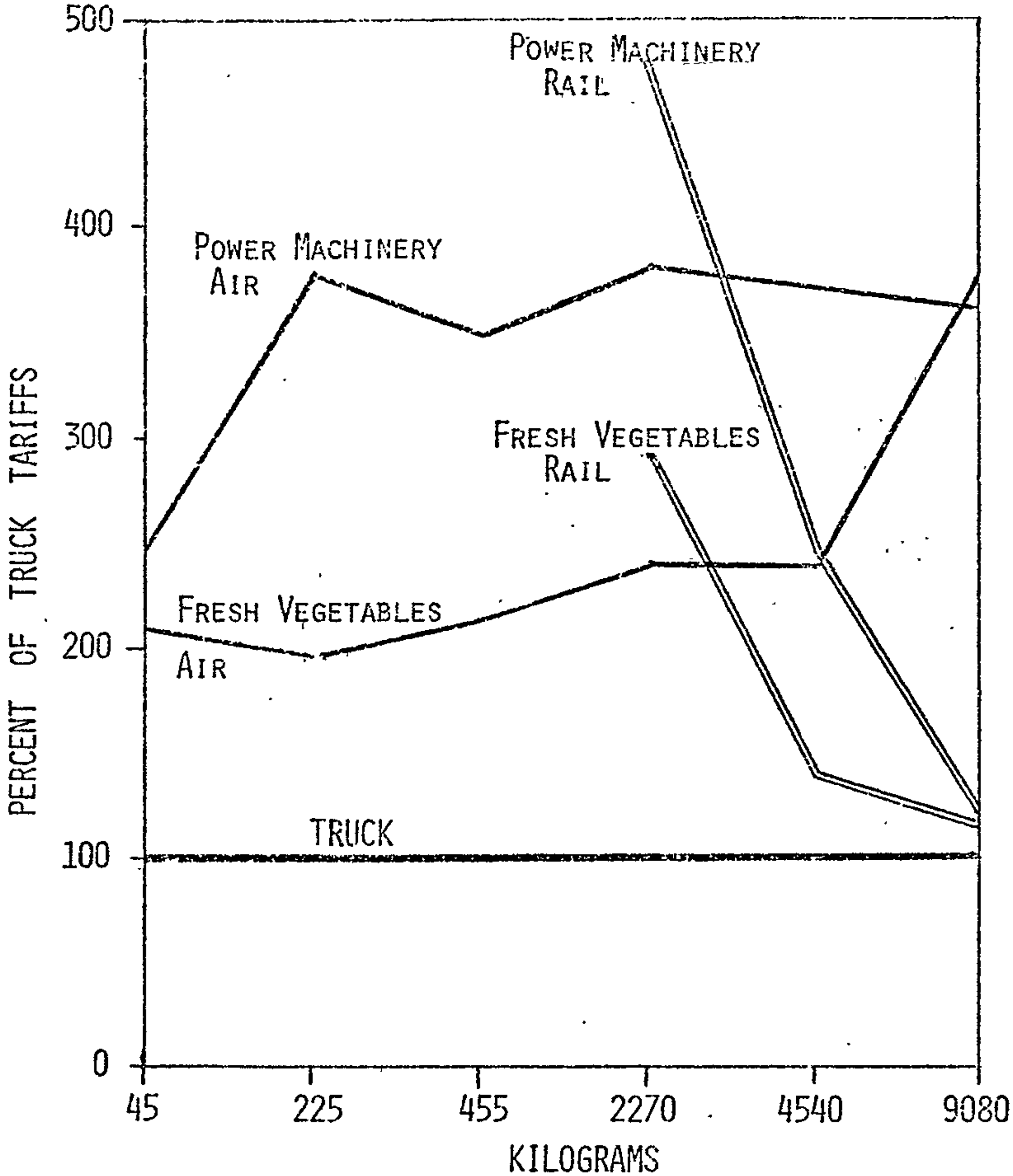

Figure 4-5. Air and Rail Tariffs as a Percent of Truck Tariffs
New York to Los Angeles

TABLE 4-17

CURRENT TARIFF STRUCTURE
ROUTE: FRANKFURT (HAMBURG FOR OCEAN) TO TOKYO

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)
Fresh Vegetables Air GCR ¢/kg Ocean GCR ¢/kg	828.70 222.34	692.06 44.47	425.37 31.56	425.37 31.56	425.37 31.56	425.37 31.56	425.37 31.56
Air % of Ocean	373	1556	1348	1348	1348	1348	1348
Medicine Air GCR ¢/kg Ocean GCR ¢/kg	828.70 453.18	412.15 90.63	268.89 50.85	246.85 50.85	246.85 50.85	246.85 50.85	246.85 50.85
Air % of Ocean	183	454	528	485	485	485	485
Power Machinery Air GCR ¢/kg Ocean GCR ¢/kg	828.70 385.88	268.89 77.18	268.89 66.03	246.85 66.03	246.85 66.03	246.85 66.03	246.85 66.03
Air % of Ocean	215	345	407	373	373	373	373
Computers Air GCR ¢/kg Ocean GCR ¢/kg	828.70 433.18	308.56 90.63	308.56 74.15	246.85 74.15	246.85 74.15	246.85 74.15	246.85 74.15
Air % of Ocean	183	341	416	333	333	333	333
Electric Machinery Air GCR ¢/kg Ocean GCR ¢/kg	828.70 385.88	268.89 77.18	268.89 57.31	246.85 57.31	246.85 57.31	246.85 57.31	246.85 57.31
Air % of Ocean	215	348	469	430	430	430	430
Clothing Air GCR ¢/kg Ocean GCR ¢/kg	363.66 403.59	244.64 112.10	244.64 112.10	238.03 112.10	238.03 112.10	238.03 112.10	238.03 112.10
Air % of Ocean	90	219	219	213	213	213	213

TABLE 4-18

CURRENT TARIFF STRUCTURE
ROUTE: TOKYO TO FRANKFURT (HAMBURG FOR OCEAN)

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)
Fresh Vegetables							
Air GCR ¢/kg	603.90	603.90	425.37	425.37	425.37	425.37	425.37
Ocean GCR ¢/kg	NA	NA	NA	NA	NA	NA	NA
Air % of Ocean	NA	NA	NA	NA	NA	NA	NA
Medicine							
Air GCR ¢/kg	603.90	412.15	412.15	412.15	412.15	412.15	412.15
Ocean GCR ¢/kg	409.48	81.89	45.95	45.95	45.95	45.95	45.95
Air % of Ocean	147	503	897	897	897	897	897
Power Machinery							
Air GCR ¢/kg	603.90	603.90	425.37	425.37	425.37	425.37	425.37
Ocean GCR ¢/kg	409.48	81.89	70.06	70.06	70.06	70.06	70.06
Air % of Ocean	147	737	607	607	607	607	607
Computers							
Air GCR ¢/kg	603.90	423.17	423.17	396.72	396.72	396.72	396.72
Ocean GCR ¢/kg	409.48	81.89	67.01	67.01	67.01	67.01	67.01
Air % of Ocean	147	517	631	592	592	592	592
Electric Machinery							
Air GCR ¢/kg	603.90	603.90	425.37	425.37	425.37	425.37	425.37
Ocean GCR ¢/kg	254.62	50.92	37.81	37.81	37.81	37.81	37.81
Air % of Ocean	237	1186	1125	1125	1125	1125	1125
Clothing							
Air GCR ¢/kg	603.90	381.29	357.05	339.42	339.42	339.42	339.42
Ocean GCR ¢/kg	252.66	70.19	70.19	70.19	70.19	70.19	70.19
Air % of Ocean	239	543	509	484	484	484	484

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TABLE 4-19

CURRENT TARIFF STRUCTURE
ROUTE: LONDON TO NEW YORK CITY

Commodity	Weight in Kilograms					
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)
Fresh Vegetables Air GCR ¢/kg Ocean GCR ¢/kg	 268.89 283.89	 138.85 56.78	 85.96 40.29	 85.96 40.29	 85.96 40.29	 85.96 40.29	 85.96 40.29
Air % of Ocean	95	245	213	213	213	213	213
Medicine Air GCR ¢/kg Ocean GCR ¢/kg	 268.89 263.89	 147.67 52.78	 125.63 29.64	 125.63 29.64	 125.63 29.64	 125.63 29.64	 125.63 29.64
Air % of Ocean	102	280	424	424	424	424	424
Power Machinery Air GCR ¢/kg Ocean GCR ¢/kg	 268.89 242.22	 121.22 48.44	 121.22 41.50	 110.20 41.50	 110.20 41.50	 110.20 41.50	 110.20 41.50
Air % of Ocean	111	250	292	266	266	266	266
Computers Air GCR ¢/kg Ocean GCR ¢/kg	 268.89 242.22	 138.85 48.44	 119.02 39.58	 103.59 39.58	 103.59 39.58	 103.59 39.58	 103.59 39.58
Air % of Ocean	111	287	301	262	262	262	262
Electric Machinery Air GCR ¢/kg Ocean GCR ¢/kg	 268.89 242.22	 121.22 48.44	 121.22 36.01	 110.20 36.01	 110.20 36.01	 110.20 36.01	 110.20 36.01
Air % of Ocean	111	250	337	306	306	306	306
Clothing Air GCR ¢/kg Ocean GCR ¢/kg	 268.89 234.44	 132.24 65.13	 125.63 65.13	 125.63 65.13	 125.63 65.13	 125.63 65.13	 125.63 65.13
Air % of Ocean	115	203	193	193	193	193	193

TABLE 4-20

CURRENT TARIFF STRUCTURE
ROUTE: NEW YORK CITY TO LONDON

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)
Fresh Vegetables Air GCR ¢/kg Ocean GCR ¢/kg	 286.52 507.78	 147.67 101.56	 92.57 50.22	 92.57 25.72	 92.57 25.72	 92.57 25.72	 92.57 25.72
Air % of Ocean	56	145	184		360	360	360
Medicine Air GCR ¢/kg Ocean GCR ¢/kg	 286.52 485.56	 156.48 97.11	 132.24 48.16	 132.24 48.16	 132.24 48.16	 132.24 48.16	 132.24 48.16
Air % of Ocean	59	161	275	275	275	275	275
Power Machinery Air GCR ¢/kg Ocean GCR ¢/kg	 286.52 395.56	 130.04 79.11	 121.22 59.80	 116.81 59.80	 116.81 59.80	 116.81 59.80	 116.81 59.80
Air % of Ocean	72	164	203	195	195	195	195
Computers Air GCR ¢/kg Ocean GCR ¢/kg	 286.52 363.33	 147.67 72.67	 125.63 52.37	 110.20 52.37	 110.20 52.37	 110.20 52.37	 110.20 52.37
Air % of Ocean	79	203	240	210	210	210	210
Electric Machinery Air GCR ¢/kg Ocean GCR ¢/kg	 286.52 363.33	 130.04 72.67	 121.22 47.67	 116.81 47.67	 116.81 47.67	 116.81 47.67	 116.81 47.67
Air % of Ocean	79	179	254	245	245	245	245
Clothing Air GCR ¢/kg Ocean GCR ¢/kg	 286.52 281.27	 141.06 97.89	 132.24 96.12	 132.24 96.12	 132.24 96.12	 132.24 96.12	 132.24 96.12
Air % of Ocean	102	144	138	138	138	138	138

TABLE 4-21

CURRENT TARIFF STRUCTURE
ROUTE: RIO DE JANEIRO TO NEW YORK CITY

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)
Fresh Vegetables							
Air GCR ¢/kg	202.77	116.81	103.59	103.59	103.59	103.59	103.59
Ocean GCR ¢/kg	318.58	63.71	45.22	45.22	45.22	45.22	45.22
Air % of Ocean	64	183	229	229	229	229	229
Medicine							
Air GCR ¢/kg	202.77	116.81	103.59	103.59	103.59	103.59	103.59
Ocean GCR ¢/kg	701.11	140.22	78.68	78.68	78.68	78.68	78.68
Air % of Ocean	29	83	132	132	132	132	132
Power Machinery							
Air GCR ¢/kg	202.77	116.81	103.59	103.59	103.59	103.59	103.59
Ocean GCR ¢/kg	270.66	54.12	46.30	46.30	46.30	46.30	46.30
Air % of Ocean	75	216	224	224	224	224	224
Computers							
Air GCR ¢/kg	202.77	116.81	74.94	68.32	68.32	68.32	68.32
Ocean GCR ¢/kg	394.44	78.89	64.55	64.55	64.55	64.55	64.55
Air % of Ocean	51	148	161	106	106	106	106
Electric Machinery							
Air GCR ¢/kg	202.77	116.81	103.59	103.59	103.59	103.59	103.59
Ocean GCR ¢/kg	394.44	78.89	58.58	58.58	58.58	58.58	58.58
Air % of Ocean	51	148	177	177	177	177	177
Clothing							
Air GCR ¢/kg	202.77	116.81	103.59	90.36	90.36	90.36	90.36
Ocean GCR ¢/kg	948.33	263.43	263.43	263.43	263.43	263.43	263.43
Air % of Ocean	21	44	39	34	34	34	34

TABLE 4-22

CURRENT TARIFF STRUCTURE
ROUTE: NEW YORK CITY TO RIO DE JANEIRO

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)
Fresh Vegetables Air GCR ¢/kg Ocean GCR ¢/kg	308.56 450.00	308.56 90.00	202.77 55.68	202.77 53.66	202.77 53.40	202.77 53.28	202.77 53.28
Air % of Ocean	69	343	364	378	380	381	381
Medicine Air GCR ¢/kg Ocean GCR ¢/kg	308.56 454.24	308.56 90.85	202.77 45.05	202.77 43.02	202.77 42.77	202.77 42.64	202.77 42.64
Air % of Ocean	68	340	450	471	474	476	476
Power Machinery Air GCR ¢/kg Ocean GCR ¢/kg	308.56 358.89	308.56 71.78	202.77 52.42	202.77 50.90	202.77 50.65	202.77 50.52	202.77 50.52
Air % of Ocean	86	430	383	398	400	401	401
Computers Air GCR ¢/kg Ocean GCR ¢/kg	308.56 392.22	308.56 78.44	202.77 55.38	202.77 53.30	202.77 53.12	202.77 52.97	202.77 52.97
Air % of Ocean	79	393	366	380	382	383	383
Electric Machinery Air GCR ¢/kg Ocean GCR ¢/kg	308.56 392.22	308.56 78.44	202.77 50.63	202.77 48.61	202.77 48.37	202.77 48.22	202.77 48.22
Air % of Ocean	79	393	400	417	419	421	421
Clothing GCR ¢/kg Air GCR ¢/kg Ocean GCR ¢/kg	308.56 392.22	308.56 95.13	202.77 92.54	202.77 90.52	202.77 90.28	202.77 90.12	202.77 90.12
Air % of Ocean	79	324	219	224	225	225	225

TABLE 4-23

CURRENT TARIFF STRUCTURE
ROUTE: FRANKFURT (BREMERHAVEN FOR OCEAN) TO NEW YORK CITY

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)
Fresh Vegetables							
Air GCR ¢/kg	301.95	209.38	94.77	94.77	94.77	94.77	94.77
Ocean GCR ¢/kg	515.00	103.00	73.06	73.06	73.06	73.06	73.06
Air % of Ocean	59	203	130	130	130	130	130
Medicine							
Air GCR ¢/kg	301.95	152.08	130.04	130.04	130.04	130.04	130.04
Ocean GCR ¢/kg	232.22	46.44	26.07	26.07	26.07	26.07	26.07
Air % of Ocean	130	327	499	499	499	499	499
Power Machinery							
Air GCR ¢/kg	301.95	127.83	121.22	116.81	116.81	116.81	116.81
Ocean GCR ¢/kg	206.67	41.33	35.40	35.40	35.40	35.40	35.40
Air % of Ocean	146	309	342	330	330	330	330
Computers							
Air GCR ¢/kg	301.95	145.46	123.42	110.20	110.20	110.20	110.20
Ocean GCR ¢/kg	250.00	50.00	40.83	31.03	31.03	31.03	31.03
Air % of Ocean	121	291	302	355	355	355	355
Electric Machinery							
Air GCR ¢/kg	301.45	127.83	121.22	116.81	116.81	116.81	116.81
Ocean GCR ¢/kg	250.00	50.00	37.17	28.25	28.25	28.25	28.25
Air % of Ocean	121	256	326	413	413	413	413
Clothing							
Air GCR ¢/kg	301.95	185.14	138.85	130.04	130.04	130.04	130.04
Ocean GCR ¢/kg	145.00	54.17	54.17	54.17	54.17	54.17	54.17
Air % of Ocean	155	342	256	240	240	240	240

C-6

TABLE 4-24

CURRENT TARIFF STRUCTURE
ROUTE: NEW YORK CITY TO FRANKFURT (BREMERHAVEN BY OCEAN)

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)
Fresh Vegetables							
Air GCR ¢/kg	319.58	154.28	99.18	99.18	99.18	99.18	99.18
Ocean GCR ¢/kg	352.78	70.56	44.17	44.17	44.17	44.17	44.17
Air % of Ocean	91	219	225	225	225	225	225
Medicine							
Air GCR ¢/kg	319.58	163.10	138.85	138.85	138.85	138.85	138.85
Ocean GCR ¢/kg	591.67	108.33	53.73	53.73	53.73	53.73	53.73
Air % of Ocean	59	151	258	258	258	258	258
Power Machinery							
Air GCR ¢/kg	319.58	134.44	134.44	123.42	123.42	123.42	123.42
Ocean GCR ¢/kg	375.56	75.11	56.78	56.78	56.78	56.78	56.78
Air % of Ocean	85	179	237	217	217	217	217
Computers							
Air GCR ¢/kg	319.58	154.28	130.04	119.02	119.02	119.02	119.02
Ocean GCR ¢/kg	305.00	61.00	43.97	43.97	43.97	43.97	43.97
Air % of Ocean	105	253	296	271	271	271	271
Electric Machinery							
Air GCR ¢/kg	319.58	134.44	134.44	123.42	123.42	123.42	123.42
Ocean GCR ¢/kg	305.00	61.00	40.00	40.00	40.00	40.00	40.00
Air % of Ocean	105	220	336	309	309	309	309
Clothing							
Air GCR ¢/kg	196.16	147.67	147.67	138.85	138.85	138.85	138.85
Ocean GCR ¢/kg	253.22	62.20	62.20	62.20	62.20	62.20	62.20
Air % of Ocean	77	237	237	223	223	223	223

TABLE 4-25

CURRENT TARIFF STRUCTURE
ROUTE: JAKARTA TO LOS ANGELES

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)
Fresh Vegetables Air GCR ¢/kg Ocean GCR ¢/kg	 403.33 NA	 315.17 NA	 286.52 NA	 286.52 NA	 286.52 NA	 286.52 NA	 286.52 NA
Air % of Ocean	NA	NA	NA	NA	NA	NA	NA
Medicine Air GCR ¢/kg Ocean GCR ¢/kg	 403.33 399.44	 235.83 79.89	 235.83 44.87	 235.83 44.87	 235.83 44.87	 235.83 44.87	 235.83 44.87
Air % of Ocean	101	395	526	526	526	526	526
Power Machinery Air GCR ¢/kg Ocean GCR ¢/kg	 403.33 399.44	 315.17 79.89	 286.52 68.41	 286.52 68.41	 286.52 68.41	 286.52 68.41	 286.52 68.41
Air % of Ocean	101	395	419	419	419	419	419
Computers Air GCR ¢/kg Ocean GCR ¢/kg	 403.33 399.84	 315.17 79.89	 286.52 65.26	 286.52 65.26	 286.52 65.26	 286.52 65.26	 286.52 65.26
Air % of Ocean	101	395	439	439	439	439	439
Electric Machinery Air GCR ¢/kg Ocean GCR ¢/kg	 403.33 399.44	 315.17 79.89	 286.52 59.40	 286.52 59.40	 286.52 59.40	 286.52 59.40	 286.52 59.40
Air % of Ocean	101	395	482	482	482	482	482
Clothing Air GCR ¢/kg Ocean GCR ¢/kg	 403.33 241.93	 315.17 67.22	 286.52 67.22	 286.52 67.22	 286.52 67.22	 286.52 67.22	 286.52 67.22
Air % of Ocean	167	469	426	426	426	426	426

TABLE 4-26

CURRENT TARIFF STRUCTURE
ROUTE: LOS ANGELES TO JAKARTA

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)
Fresh Vegetables Air GCR ¢/kg Ocean GCR ¢/kg	 403.33 306.67	 315.17 61.33	 286.52 44.15	 286.52 44.15	 286.52 44.15	 286.52 44.15	 286.52 44.15
Air % of Ocean	132		649	649	649	649	649
Medicine Air GCR ¢/kg Ocean GCR ¢/kg	 403.33 306.67	 315.17 61.33	 286.52 34.45	 286.52 34.45	 286.52 34.45	 286.52 34.45	 286.52 34.45
Air % of Ocean	132	514	832	832	832	832	832
Power Machinery Air GCR ¢/kg Ocean GCR ¢/kg	 403.33 306.67	 315.17 61.33	 286.52 52.52	 286.52 52.52	 286.52 52.52	 286.52 52.52	 286.52 52.52
Air % of Ocean	132	514	546	546	546	546	546
Computers Air GCR ¢/kg Ocean GCR ¢/kg	 403.33 306.67	 315.17 61.33	 286.52 50.10	 286.52 50.10	 286.52 50.10	 286.52 50.10	 286.52 50.10
Air % of Ocean	132	514	572	572	572	572	572
Electric Machinery Air GCR ¢/kg Ocean GCR ¢/kg	 403.33 306.67	 315.17 61.33	 286.52 45.60	 286.52 45.60	 286.52 45.60	 286.52 45.60	 286.52 45.60
Air % of Ocean	132	514	628	628	628	628	628
Clothing Air GCR ¢/kg Ocean GCR ¢/kg	 403.33 311.11	 315.17 85.21	 286.52 85.21	 286.52 85.21	 286.52 85.21	 286.52 85.21	 286.52 85.21
Air % of Ocean	130	370	336	336	336	336	336

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TABLE 4-27

CURRENT TARIFF STRUCTURE
ROUTE: LOS ANGELES TO TOKYO

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)
Fresh Vegetables Air GCR ¢/kg Ocean GCR ¢/kg	 365.86 388.89	 90.36 77.78	 90.36 55.19	 90.36 55.19	 90.36 55.19	 90.36 55.19	 90.36 55.19
Air % of Ocean	97	116	164	164	164	164	164
Medicine Air GCR ¢/kg Ocean GCR ¢/kg	 365.86 324.44	 231.42 64.89	 202.77 36.43	 202.77 36.43	 202.77 36.43	 202.77 36.43	 202.77 36.43
Air % of Ocean	113	357	557	557	557	557	557
Power Machinery Air GCR ¢/kg Ocean GCR ¢/kg	 365.86 304.44	 297.54 60.89	 209.38 52.15	 209.38 52.15	 209.38 52.15	 209.38 52.15	 209.38 52.15
Air % of Ocean	120	489	402	402	402	402	402
Computers Air GCR ¢/kg Ocean GCR ¢/kg	 365.86 311.11	 297.54 62.22	 189.54 50.82	 167.50 50.82	 167.50 50.82	 167.50 50.82	 167.50 50.82
Air % of Ocean	118	478	373	330	330	330	330
Electric Machinery Air GCR ¢/kg Ocean GCR ¢/kg	 365.86 186.67	 297.54 37.33	 209.38 27.75	 209.38 27.75	 209.38 27.75	 209.38 27.75	 209.38 27.75
Air % of Ocean	196	797	755	755	755	755	755
Clothing Air GCR ¢/kg Ocean GCR ¢/kg	 365.86 175.56	 209.38 48.78	 209.38 48.78	 189.54 48.78	 189.54 48.78	 189.54 48.78	 189.54 48.78
Air % of Ocean	208	429	429	389	389	389	389

TABLE 4-28

CURRENT TARIFF STRUCTURE
ROUTE: TOKYO TO LOS ANGELES

Commodity	Weight in Kilograms						
	45	225	455	2270	4540	9080	>9080 (up to 18 160#)
Fresh Vegetables Air GCR ¢/kg Ocean GCR ¢/kg	 365.86 431.11	 297.54 86.22	 209.38 61.16	 209.38 61.16	 209.38 61.16	 209.38 61.16	 209.38 61.16
Air % of Ocean	85	345	342	342	342	342	342
Medicine Air GCR ¢/kg Ocean GCR ¢/kg	 365.86 333.33	 297.54 66.67	 209.38 37.45	 209.38 37.45	 209.38 37.45	 209.38 37.45	 209.38 37.45
Air % of Ocean	110	146	559	559	559	559	559
Power Machinery Air GCR ¢/kg Ocean GCR ¢/kg	 365.86 220.00	 209.38 44.00	 178.52 37.69	 167.50 37.69	 167.50 37.69	 167.50 37.69	 167.50 37.69
Air % of Ocean	166	476	474	444	444	444	444
Computers Air GCR ¢/kg Ocean GCR ¢/kg	 365.86 280.00	 297.54 56.00	 209.38 45.76	 209.38 45.76	 209.38 45.76	 209.38 45.76	 209.38 45.76
Air % of Ocean	131	531	458	458	458	458	458
Electric Machinery Air GCR ¢/kg Ocean GCR ¢/kg	 365.86 213.33	 209.38 42.67	 178.52 31.72	 167.50 31.72	 167.50 31.72	 167.50 31.72	 167.50 31.72
Air % of Ocean	171	491	563	528	528	528	528
Clothing Air GCR ¢/kg Ocean GCR ¢/kg	 365.86 154.44	 209.38 42.91	 180.73 42.91	 180.73 42.91	 180.73 42.91	 180.73 42.91	 180.73 42.91
Air % of Ocean	237	488	421	421	421	421	421

- Air tariffs as a percent of ocean tariffs fall at every air rate break since ocean tariffs are constant per kilogram. This behavior is illustrated in Figure 4-6 which presents the data for two commodities on the Tokyo-to-Los Angeles route.
- Significant air tariff rate breaks exist at 225, 455, and 2270 kg.

Transit Times

The third most important criterion in the choice of transport mode, Table 4-6, is time in transit. Comparative domestic and international pickup to delivery times are presented in Tables 4-29 and 4-30, respectively, as derived from the sources listed in References 4-3 through 4-10. The following relevant observations can be drawn from these data as illustrated in Figures 4-7 and 4-8.

- For the domestic routes considered, the airfreight transit times are approximately 1/2 to 1/5 of the motor carrier transit times and 1/3 to 1/6 of the rail transit times.
- For the international routes considered the airfreight transit times are approximately 1/11 to 1/27 of the ocean freight transit times.

Service Factors

Excluding tariffs and time in transit, the more important of the remaining service criteria identified in Table 4-6, are considered in this section under the general term Quality of Service. Tables 4-31 through 4-38 present an intermodal comparison of this quality of service as a function of the following categorization of shippers: all shippers, by scope of operation, by annual freight bill, by modal orientation, by shipping pattern, by volume shipped, and by service factor.

A general pattern of service level provided by the respective modes is evident in Figure 4-9, a geographical presentation of the data in Table 4-31 (Reference 4-11). The airfreight and motor carrier industries provide the best service with the former being rated excellent by 17 percent, and the latter by 10 percent of the shippers. Although water carriage is noticeably below air and motor carriage, it is significantly better than rail carriage in the provision of service.

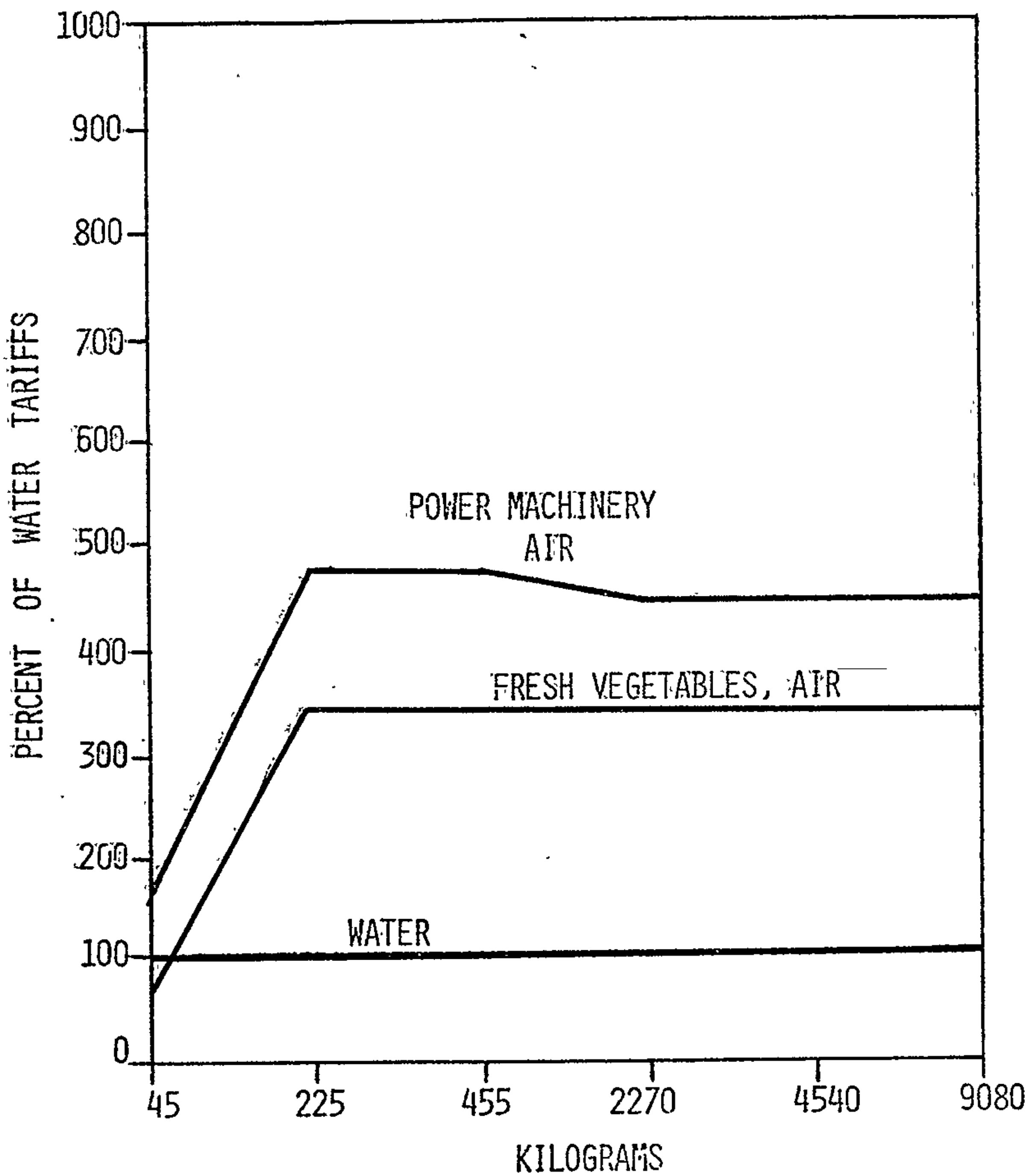


Figure 4-6. Air Tariffs as a Percent of Water Tariffs
Tokyo to Los Angeles

TABLE 4-29

DOMESTIC TRANSIT TIMES

Route	Air		Truck	Rail
	Line-Haul Time	Delivery	Delivery	Delivery
LA TO NY	5:10	Next Morning	5th Morning	5 - 6 Days
NY TO LA	5:32	Next Morning	5th Morning	5 - 6 Days
SF TO NY	5:18	Next Morning	5th Morning	5 - 6 Days
NY TO SF	5:45	Next Morning	5th Morning	5 - 6 Days
LA TO CHI	3:42	Next Morning	3rd Morning	2-1/2 - 3 Days
CHI TO LA	3:53	Next Morning	3rd Morning	2-1/2 - 3 Days
SF TO CHI	3:53	Next Morning	3rd Morning	2-1/2 - 3 Days
CHI TO SF	4:08	Next Morning	3rd Morning	2-1/2 - 3 Days
NY TO CHI	2:10	Next Morning	Next Day	2-1/2 - 3 Days
CHI TO NY	1:52	Next Morning	Next Day	2-1/2 - 3 Days

TABLE 4-30

INTERNATIONAL TRANSIT TIMES

Route	Air (Scheduled)		Ocean
	Time	Delivery	Delivery
LA TO TOKYO	13:50	Next Day	13 Days
TOKYO TO LA	10:00	Next Day	10 Days
LA TO JAKARTA	32:25	2 Days	26 Days
JAKARTA TO LA	23:45	1-1/2 Days	40 Days
NY TO FRANKFURT (BREMERHAVEN)	8:15	Next Day	11 Days
FRANKFURT TO NY (BREMERHAVEN)	7:10	Next Day	11 Days
NY TO RIO	11:45	Next Day	21 - 25 Days
RIO TO NY	9:50	Next Day	21 - 25 Days
NY TO LONDON	7:00	Next Day	12 Days
LONDON TO NY	7:50	Next Day	13 Days
TOKYO TO FRANKFURT (HAMBURG)	17:05	Next Day	27 Days
FRANKFURT TO TOKYO (HAMBURG)	18:05	Next Day	30 Days

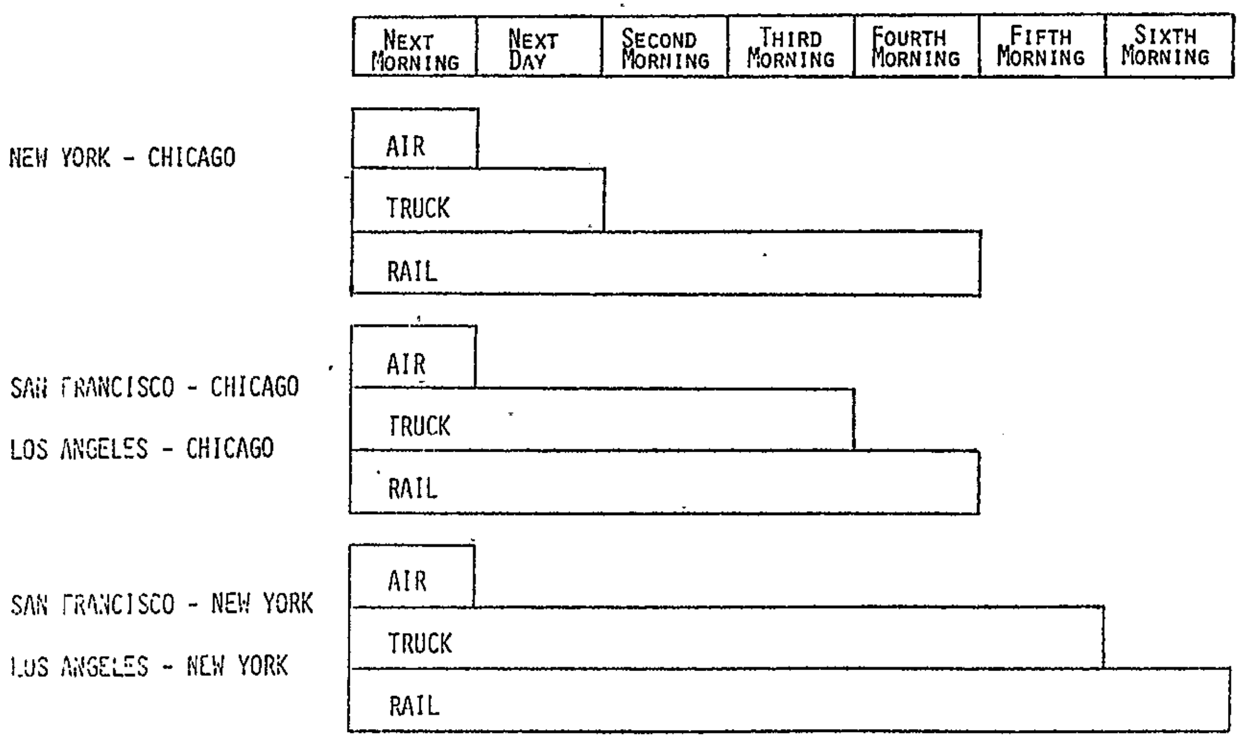


Figure 4-7. Line Haul Times by Mode Domestic Freight

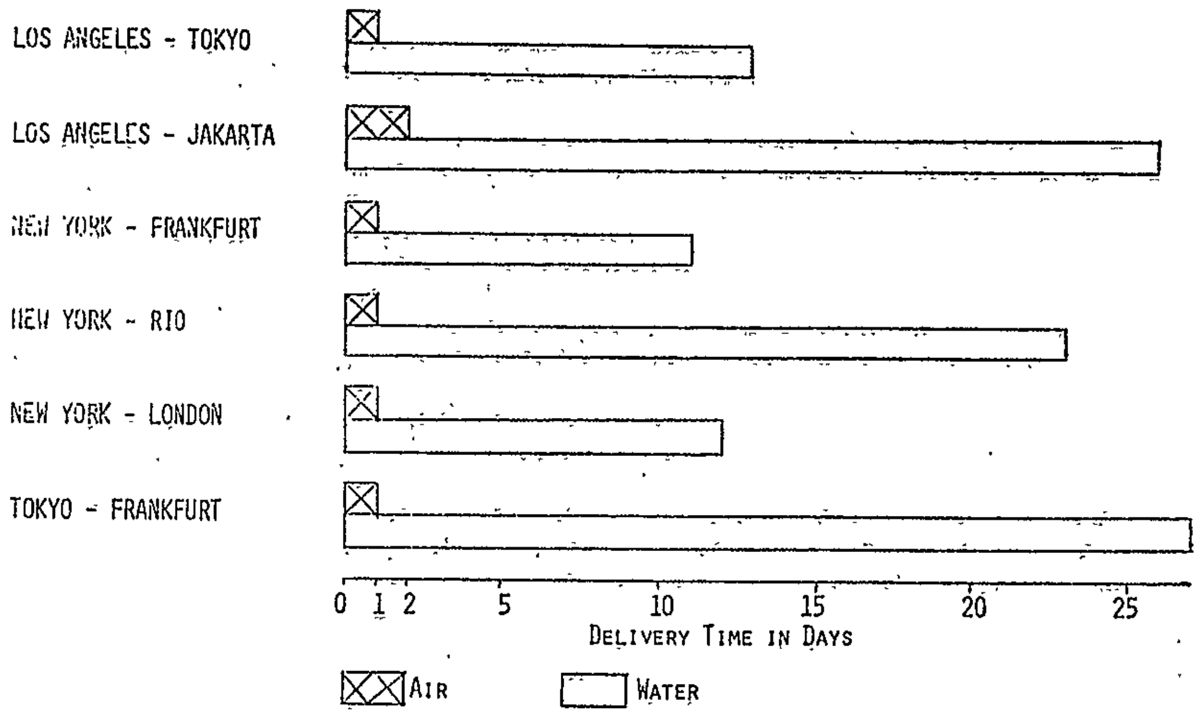


Figure 4-8. Line Haul Times by Mode International Freight

TABLE 4-31

QUALITY OF SERVICE AFFORDED SHIPPERS BY MODE

Mode	% Excellent	Cumulative %	% Quite Good	Cumulative %	% Adequate	Cumulative %	% Minimally Acceptable	Cumulative %	% Unsatisfactory	Cumulative %	Total Using Mode
1. Motor Carrier	10.36	10.36	56.48	66.84	30.57	97.41	2.07	99.48	0.52	100	193
2. Rail	5.43	5.43	16.28	21.71	44.19	65.90	24.81	90.70	9.30	100	129
3. Air	16.92	16.92	51.54	68.46	26.92	95.38	4.62	100	0	100	130
4. Water	8.93	8.93	25.00	33.93	60.71	94.64	5.36	100	0	100	56

TABLE 4-32

PERCENTAGE OF CARRIERS CONSIDERED TO BE RENDERING GOOD SERVICE

Mode	% of Respondents Stating Good Service Rendered by			
	Mean % of Carriers Said to Give Good Service	100% of Carriers	At Least 80% of Carriers	0% of Carriers
1. Motor Carriers	80	38	73	1
2. Rail	66	49	56	22
3. Air	93	83	88	2
4. Water	85	83	83	5

TABLE 4-33

QUALITY OF SERVICE BY SCOPE OF OPERATION

Scope of Shipper Operation	Mode	% Excellent	Cumulative %	% Quite Good	Cumulative %	% Adequate	Cumulative %	% Minimally Acceptable	Cumulative %	% Unsatisfactory	Cumulative %	Total Respondents
Regional	Motor	14.63	14.63	63.42	78.05	19.51	97.56	2.44	100	0	100	41
	Rail	13.79	13.79	13.79	27.58	44.83	72.41	27.59	100	0	100	29
	Air	11.11	11.11	77.78	88.89	11.11	100	0	100	0	100	9
	Water	37.50	37.50	25.00	62.50	25.00	87.50	12.50	100	0	100	8
Nationwide	Motor	9.33	9.33	54.00	63.33	34.00	97.33	2.00	99.33	0.67	100	150
	Rail	3.06	3.06	16.33	19.39	54.08	73.47	14.29	87.76	12.24	100	98
	Air	17.50	17.50	50.00	67.50	27.50	95.00	5.00	100	0	100	120
	Water	4.17	4.17	25.00	29.17	66.66	95.83	4.17	100	0	100	48

TABLE 4-34

QUALITY OF SERVICE BY ANNUAL FREIGHT BILL

Annual Freight Bill	Mode	% Excellent	Cumulative %	% Quite Good	Cumulative %	% Adequate	Cumulative %	% Minimally Acceptable	Cumulative %	% Unsatisfactory	Cumulative %	Total Respondents
More than $5 000 000	Motor	5.00	5.00	50.00	55.00	45.00	100	0	100	0	100	20
	Rail	0	0	11.11	11.11	50.00	61.11	16.67	77.78	22.22	100	18
	Air	15.38	15.31	46.23	61.54	30.77	92.31	7.69	100	0	100	13
	Water	0	0	14.29	14.29	85.71	100	0	100	0	100	7
$1 000 000 to $5 000 000	Motor	6.78	6.78	59.32	66.10	28.82	94.92	3.39	98.31	1.69	100	59
	Rail	0	0	10.42	10.42	52.08	62.50	27.08	89.58	20.42	100	48
	Air	11.43	11.43	51.43	62.86	31.43	94.29	5.71	100	0	100	35
	Water	13.33	13.33	6.67	20.00	73.33	93.33	6.67	100	0	100	15
$500 000 to $999 999	Motor	7.32	7.32	58.53	65.85	34.15	100	0	100	0	100	41
	Rail	7.14	7.14	25.00	32.14	45.72	67.86	25.00	92.86	7.14	100	28
	Air	7.41	7.41	66.66	74.07	22.22	96.29	3.71	100	0	100	27
	Water	7.69	7.69	38.46	46.15	53.85	100	0	100	0	100	13
Less than $500 000	Motor	16.44	16.44	54.79	71.23	26.03	97.26	2.74	100	0	100	73
	Rail	14.29	14.29	20.00	34.29	37.14	71.43	25.71	97.14	2.86	100	35
	Air	25.45	25.45	45.45	70.90	25.45	96.35	3.65	100	0	100	55
	Water	9.52	9.52	33.33	42.85	47.62	90.47	9.53	100	0	100	21

TABLE 4-35

QUALITY OF SERVICE BY MODAL ORIENTATION

Principal Mode Used	Mode	% Excellent	Cumulative %	% Quite Good	Cumulative %	% Adequate	Cumulative %	% Minimally Acceptable	Cumulative %	% Unsatisfactory	Cumulative %	Total Respondents
Motor	Motor	10.69	10.69	57.23	67.92	28.93	96.85	2.52	99.37	0.63	100	159
	Rail	4.90	4.90	14.71	19.61	48.04	67.65	23.53	91.18	8.82	100	102
	Air	15.60	15.60	52.29	67.89	27.52	95.41	4.59	100	0	100	109
	Water	6.38	6.38	27.66	34.04	59.57	93.61	6.39	100	0	100	47
Rail	Motor	4.00	4.00	52.00	56.00	44.00	100	0	100	0	100	25
	Rail	4.00	4.00	24.00	28.00	32.00	60.00	28.00	88.00	12.00	100	25
	Air	16.67	16.67	50.00	66.67	25.00	91.67	8.33	100	0	100	12
	Water	14.29	14.29	0	14.29	85.71	100	0	100	0	100	7

TABLE 4-36

QUALITY OF SERVICE BY SHIPPING PATTERN

Principal Size of Shipment	Mode	% Excellent	Cumulative %	% Quite Good	Cumulative %	% Adequate	Cumulative %	% Minimally Acceptable	Cumulative %	% Unsatisfactory	Cumulative %	Number Responding
Volume TL	Motor	15.79	15.79	68.42	84.21	14.04	98.25	1.75	100	0	100	57
	Rail	9.52	9.52	9.52	19.04	50.00	69.04	21.43	90.47	9.53	100	42
	Air	20.69	20.69	44.83	65.52	27.59	93.11	6.89	100	0	100	29
	Water	23.53	23.53	11.76	35.29	52.94	88.23	11.77	100	0	100	17
Volume CL	Motor	4.00	4.00	44.00	48.00	48.00	96.00	4.00	100	0	100	25
	Rail	4.00	4.00	28.00	32.00	32.00	64.00	28.00	92.00	8.00	100	25
	Air	18.18	18.18	45.45	63.63	27.27	90.90	9.10	100	0	100	11
	Water	14.29	14.29	14.29	28.58	71.42	100	0	100	0	100	7
LTL	Motor	12.73	12.73	49.09	61.82	32.73	94.55	1.82	96.37	3.63	100	55
	Rail	3.13	3.13	12.50	15.63	46.88	62.51	25.00	87.51	12.49	100	32
	Air	13.51	13.51	48.65	62.16	29.73	91.89	8.11	100	0	100	37
	Water	0	0	43.75	43.75	50.00	93.75	6.25	100	0	100	16
Small Shipment	Motor	5.26	5.26	56.14	61.40	36.84	98.24	1.76	100	0	100	57
	Rail	3.33	3.33	20.00	23.33	43.33	66.66	26.67	93.34	6.66	100	30
	Air	16.98	16.98	58.49	75.47	24.53	100	0	100	0	100	53
	Water	0	0	25.00	25.00	75.00	100	0	100	0	100	16

TABLE 4-37

QUALITY OF SERVICE BY ANNUAL VOLUME SHIPPED

Annual Volume Shipped	Mode	% Excellent	Cumulative %	% Quite Good	Cumulative %	% Adequate	Cumulative %	% Minimally Acceptable	Cumulative %	% Unsatisfactory	Cumulative %	Number Responding
Large	Motor	7.50	7.50	55.00	62.50	35.00	97.50	2.50	100	0	100	40
	Rail	0	0	13.89	13.89	38.89	52.78	30.56	83.34	16.66	100	36
	Air	15.56	15.56	51.11	66.67	28.89	95.56	4.44	100	0	100	45
	Water	8.33	8.33	16.67	25.00	66.67	91.67	8.33	100	0	100	12
Medium	Motor	8.70	8.70	57.97	66.67	31.88	98.55	0	98.55	1.45	100	69
	Rail	6.78	6.78	10.17	16.95	55.93	72.88	18.64	91.52	8.48	100	59
	Air	15.56	15.56	51.11	66.67	28.89	95.56	4.44	100	0	100	45
	Water	16.67	16.67	16.67	33.34	61.11	94.45	5.55	100	0	100	18
Small	Motor	13.10	13.10	55.95	69.05	27.38	96.43	3:57	100	0	100	84
	Rail	8.82	8.82	29.41	38.23	29.41	67.64	29.41	97.05	2.95	100	34
	Air	19.72	19.72	53.52	73.24	22.54	95.78	4.22	100	0	100	71
	Water	3.85	3.85	34.62	38.47	57.69	96.16	3.84	100	0	100	26

TABLE 4-38

QUALITY OF SERVICE PROVIDED BY SERVICE FACTOR BY MODE

Performance Factor	Mode	% Excellent	Cumulative %	% Quite Good	Cumulative %	% Adequate	Cumulative %	% Minimally Acceptable	Cumulative %	% Unsatisfactory	Cumulative %	Mean % Positive Performance
On time pick up	Motor	27	27	42	69	25	94	5	99	1	100	89
	Rail	23	23	31	54	19	73	20	93	7	100	81
On time delivery	Motor	15	15	37	52	39	91	7	98	2	100	84
	Rail	7	7	25	32	32	64	22	86	14	100	70
	Air	29	29	42	71	20	91	7	98	2	100	90
	Water	32.50	32.50	30.00	62.50	27.50	90	7.50	97.50	2.50	100	85
Arrivals without loss, short or damage	Motor	31	31	44	75	18	93	5	98	2	100	94
	Rail	20	20	39	59	23	82	11	93	7	100	89
	Air	49	49	37	86	10	96	2	98	2	100	97
	Water	51	51	29	80	15	95	5	100	0	100	93
Specified Equip Avail-ability	Motor	31	31	35	66	25	91	6	97	3	100	95
	Rail	16	16	23	39	24	63	18	81	19	100	75

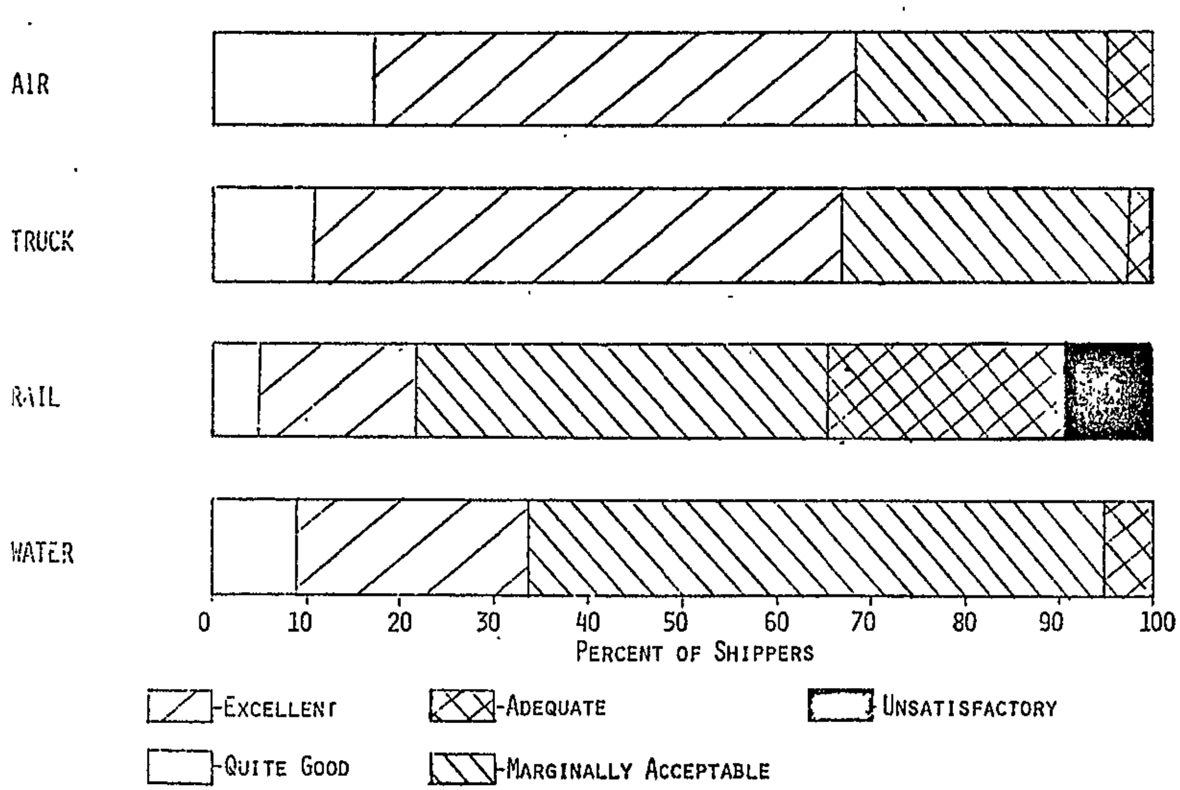


Figure 4-9. Quality of Service Afforded Shippers by Mode

Section 5

POLITICAL AND ECONOMIC FACTORS

Transportation is that aspect of economic activity that provides for the carriage of persons or property from one place to another. When the conveyance takes place between facilities, places, or firms, the use of public facilities is usually involved. The form and quantity of public facilities available depend on the economic and political systems in which the transportation systems, facilities, places, and firms exist. This section examines the dependence of airfreight on the world's changing economic and political systems.

Table 5-1 summarizes the effect of each economic and political factor on the airfreight market and future airfreight system. The economic and political factors considered include agreements and regulations, economic variables, economic and political aspects of competing modes, and the Civil Reserve Air Fleet (CRAF).

International Agreements

The effects of international agreements on the airfreight market and the future airfreight system are considered in this subsection. Four types of international agreement are considered; Bermuda II, tariffs, quotas, and voluntary quotas.

Bermuda II. - The Bermuda Agreement of 1946 between the U.S. and UK has been replaced by the Bermuda II Agreement (July 23, 1977). This new agreement, based on the significance given the 1946 Bermuda Agreement, might well serve as a model for future bilateral agreements between the U.S. and other countries. As a consequence, the airfreight industry can expect the following:

- Each origin-destination (O-D) to be served by approximately the same number of U.S. and foreign flag carriers as opposed to the

TABLE 5-1

THE EFFECT OF ECONOMIC AND POLITICAL FACTORS ON THE AIRFREIGHT MARKET AND FUTURE AIRFREIGHT SYSTEM

	Airfreight Market: Market			Airfreight Market: Nature of Demand[1/2]			Future Airfreight System[3]										
	Domestic	U.S. International	Foreign	Emergency	Perishable	Divertible	Volume	Commodities	Airports and/or Terminals / Airport Equipment	Ground	Aircraft	Network	Operations	Capacity	Economics	Entry	Rates
International Agreements																	
Bermuda II		X	X						D	IN	IN	D		IN	DOC[4]	IN	
Tariffs		X	X		II	I	+	D									
Quotas		X	X	III	II	I	+	D									
Voluntary Quotas		X	X		II	I	+	D									
Non-Economic Regulations																	
Curfews and Night Flight Rules	X	X	X	I	II	III	-		D			D	D	D	DOC/IOC[5]		IN IN
Noise	X	X	X	III	II	I			D	D	D	IN	D		DOC/IOC		
Air Pollution	X	X	X	III	II	I	-		D	D	D	IN	D		DOC/IOC		IN
Hazardous Materials	X	X	X														
Regulatory Expectations	X	X	X	III	II	I	-							D	DOC/IOC		D
Economic Regulations																	
International Tariff		X	X														D
International Economic		X	X													D	D
Domestic Market Entry	X															D	
Domestic Price	X																D
Horizontal Mergers	X															D	
Vertical Mergers	X								D						IOC	D	IN
Deregulation	X						+					D			IOC	D	D
Regulatory Expectations	X													D			

TABLE 5-1. - Continued

THE EFFECT OF ECONOMIC AND POLITICAL FACTORS ON THE AIRFREIGHT MARKET AND FUTURE AIRFREIGHT SYSTEM

	Airfreight Market: Market			Airfreight Market: Nature of Demand[1/2]			Future Airfreight System[3]										
	Domestic	U.S. International	Foreign	Emergency	Perishable	Divertible	Volume	Commodities	Airports and/or Terminals	Ground Equipment	Aircraft	Network	Operations	Capacity	Economics	Entry	Rates
Economic Variables																	
GNP	X	X	X				+										
Investment	X	X	X	I			+/-										
Airfreight Tariffs	X	X	X	III	II	I	+										
Inventory Carrying Costs	X	X	X	III	II	I											
Fuel Costs	X	X	X								D	IN		IN	DOC	IN	
Landing Fees and Taxes	X	X	X	III	II	I	-								DOC	D	
Subsidies	X	X															
Mortgaging and Leasing	X	X															
Insurance	X	X															
Product Life Cycles	X	X	X														
Exchange Rates		X	X				+										
Wage Rate Differentials		X	X				-										

TABLE 5-1. - Concluded

THE EFFECT OF ECONOMIC AND POLITICAL FACTORS ON THE AIRFREIGHT MARKET AND FUTURE AIRFREIGHT SYSTEM

	Airfreight Market						Future Airfreight System[3]										
	Market			Nature of Demand[1/2]													
	Domestic	U.S. International	Foreign	Emergency	Perishable	Divertible	Volume	Commodities	Airports and/or Terminals	Ground Equipment	Aircraft	Network	Operations	Capacity	Economics	Entry	Rates
Competitive Modes																	
Federal Express	X			I			-										
Motor Carriers	X				II	I	-										
Rail Carriers	X																
Water Carriers		X	X														
Civil Reserve Air Fleet	X	X				I		+	D	D	D	IN	IN	D	DOC		IN

1 The nature of demand classifications are also used by Schneider (Reference 5-1). The perishable classification includes physically perishable products and physically nonperishable products when their movement is time perishable (e.g., when sales depends on transit time). The divertible classification is made up of traffic which could move by air but the mode decision is made on the basis of the price service packages made available to shippers by the various modes.

2 I - largest effect, II - next largest effect, III - smallest effect.

3 D - direct effect, I_N - indirect effect.

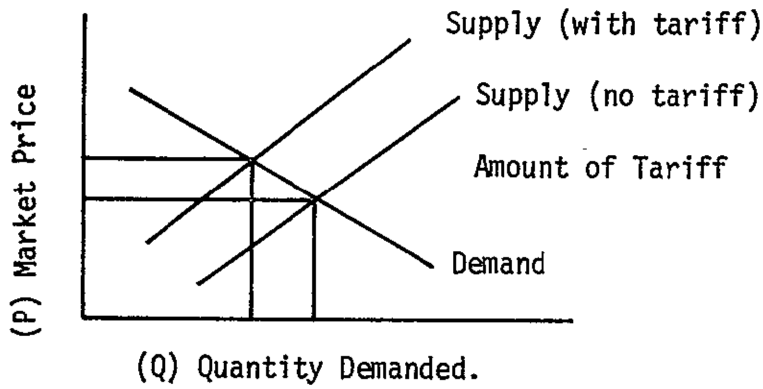
4 DOC - direct operating costs.

5 IOC - indirect operating costs.

provisions of the 1946 Bermuda Agreement which allowed many O-Ds to be served by more U.S. than foreign flag carriers. The result will be a promotion of foreign flag at the expense of American flag airline services.

- With less American flag service, some O-Ds could experience capacity limitations due to the possible inability of foreign carriers to provide comparable lift capacity in the near term future.
- Fifth freedom rights (i.e., the right to carry freight between foreign countries) to be severely limited as opposed to the liberal fifth freedom rights of the 1946 Bermuda Agreement. This important limitation will lower load factors on flights between foreign countries.
- More change of gauge points which will allow better aircraft utilization.

Tariffs, quotas, and voluntary quotas. - A tariff placed on a specific commodity decreases the supply of that commodity. Consequently, the market price of that commodity can be expected to increase and the quantity demanded can be expected to decrease. This is illustrated in the following chart. Nontariff trade barriers that increase the cost of entering a market (e.g., safety, health, environmental, and licensing requirements) have the same effect as a tariff. That is, they decrease supply. To the extent that these requirements are on the increase, the effect of tariff reductions are being diluted.



A quota placed on a specific commodity limits the quantity of the commodity that may be imported. In most cases, this corresponds more to a decrease in supply than an absolute prohibition (e.g., Japan has a quota on the amount of slaughtered beef that may be imported; consequently, Japan imports beef on the hoof). A quota can therefore be treated the same as a tariff. Because of tariffs and quotas, the following can be expected:

- As trade restrictions change, airfreight volumes will change. The change in volume on a commodity by commodity basis depends on the elasticities (i.e., dQ/dP/ P/Q) of supply and demand. The expected price elasticities of demand vary by type of freight with divertible commodities being the most sensitive followed by perishable and emergency freight. Emergency airfreight is usually considered to be so price inelastic that import restriction price changes will have a negligible effect on the quantity demanded. Only in the case of an absolute prohibition (quota), where no close substitutes exist (e.g., Caterpillar Tractor parts), will an import restriction affect emergency traffic substantially.
- Since it has been a continuing peacetime policy of the U.S. and most other countries to lower trade barriers, the anticipated future decreases in trade restriction can be expected to result in an increase in surface and airfreight volumes.
- Political integration and free trade areas are conducive to the elimination of intrabloc trade restrictions. There is a move toward more and larger such organizations (e.g., European Economic Community, European Free Trade Area, Nordic Bloc, Latin America Free Trade Area, Arab League). These organizations can be expected to stimulate intrabloc airfreight and surface volumes and to decrease trade with nonbloc nations. There is some possibility that the formation of a free-trade area might increase intrabloc income sufficiently to offset this decrease.

Even though tariffs and quotas in general are being reduced, trade restrictions on many high-value consumer goods are increasing. The effect of a trade restriction on high-value consumer goods is often to change the type of goods produced. For example, the voluntary quota placed on Japanese color TV sets by a U.S.-Japan agreement has caused the Japanese, in an effort to maximize TV dollar exports, to concentrate export sales on the more expensive models and brands. Consequently, the airfreight industry can expect the following:

- An increase in the value per pound of goods exported with an attendent potential increase in the volume of air-eligible commodities caused by trade restrictions of this type.

Noneconomic Regulations

Noneconomic regulations have a profound effect on the ability of the carriers to provide airfreight service. Five types of noneconomic regulations are considered here: curfews and night flight rules, noise regulations, air pollution standards, hazardous materials, and regulatory expectations.

Curfews and night flight rules. - In order to provide the prime time service demanded by its customers, all-cargo flights leave late in the evening and arrive early the next morning. At present, there is a move by many airports to place restrictions on flights during these hours (e.g., San Diego's Lindberg Field instigated a night curfew in December; both the Tokyo and Hong Kong airports now have night curfews; and California's Orange County Airport is tightening fast-climb rules on takeoffs). As more restrictions are enacted, the airfreight industry can expect the following:

- Restrictions on night operations will result in the elimination of some prime-time service with an accompanying impact on airfreight that is determined by the time sensitivity of the freight handled as shown in Table 5-1. It will also result in reduced capacities, changes in flight schedules, modifications to operating procedures, and increases in direct and indirect operating costs.

- All-cargo or military airports may be substituted for the affected commercial airports since military airports are, at least for the present, free of such restrictions and all-cargo airports could be located in remote areas.

<u>Noise and air pollution</u>. - Federal regulation CAB FAR 36, 1969, sets maximum acceptable aircraft noise levels. This regulation originally applied to newly produced wide-body aircraft only. Since 1969, it has been modified to include narrow-bodied aircraft (1973) and to lower the maximum acceptable noise levels (1977). In January of 1977, a new regulation, CAB FAR 91-136, Subpart E, established a timetable for extending the 1969 FAR 36 noise regulations to older jet aircraft having a maximum takeoff weight of 34 000 kilograms or greater. The associated applicatory timetable is as follows:

Date	Percent of Aircraft that Must Be Modified	
1-1-81	25%	aircraft not powered by JT-8D engines
1-1-83	50%	
1-1-85	100%	
1-1-81	50%	aircraft powered by JT-8D engines (for example, B727, B737, DC-9, etc.)
1-1-83	100%	

American aircraft in international service are exempt from this regulation until 1985 and foreign aircraft operating into the U.S. are exempt.

The Air Navigation Commission of the ICAO is charged with international noise and air pollution controls. Annex 16 requires that all newly produced subsonic aircraft meet the equivalent of FAR 36, 1969. At present, the Commission is considering a regulation (CAN 5) that will require newly produced subsonic aircraft to meet the equivalent of FAR 36, 1977. This regulation has passed committee and is expected to be approved.

In addition to the federal action, some airport proprietors have established more stringent local noise standards (e.g., Boston's Logan Field). Airport proprietors establishing more stringent noise standards must submit plans to, and obtain the approval of, the DOT in order to continue to obtain funds provided by the Airport and Airway Development Act of 1970. Los Angeles is presently in the process of establishing more-stringent noise standards similar to Boston's.

Noise abatement programs greatly increase airline expenses, especially those requiring the retrofitting of aircraft. As a result, the aircraft industry can expect the following:

- The direct operating costs of new and existing aircraft to increase with an attendant increase in freight rates and a decrease in the volume of commodities shipped as determined by their elasticities of demand.
- Required aircraft modification and possible changes in operating procedures.

Environmental impact studies are required (CAB SFAR 27) when adding origins and destinations to present service or when changing operations at an airport. This is due to the fact that any growth in operation, air and/or ground, affects pollution and noise. It is evident, therefore, that any increases in service could affect terminals or require new airports, either all freight or military, to meet air pollution and noise requirements.

Hazardous materials. - DOT CFR Title 49 establishes hazardous material regulations for all transportation modes. The enforcement of this regulation with respect to air carriers is performed by the FAA (FAR 103). Prior to the hazardous-material-related air freighter crash in November 1973, Title 49 was poorly enforced by all transportation modes. Since that time, enforcement has markedly improved. Presently, a problem exists in that Title 49 is poorly understood by the FAA, airfreight and airfreight forwarder industries, and by pilots. An attempt to make the regulations more understandable through education and a rewriting of Title 49 is in progress.

DOT CFR Title 49, as enforced by the FAA, applies on all domestic and U.S. international flights by foreign and domestic carriers. In general, the regulations are more stringent for air than surface modes. Many hazardous materials which can be transported on freighters cannot be transported on combination aircraft.

IATA hazardous material regulations are often more stringent than the corresponding Title 49 regulations. However, they are not nearly as well enforced. Consequently, effective hazardous material regulation on foreign service is presently lacking. Both IATA and FAA regulations are applicable on U.S. international flights. In the future, the airfreight industry can expect the following:

- DOT CFR Title 49 will be rewritten and more widely understood.
- IATA hazardous material regulation enforcement will gradually improve.

Regulatory expectations. - Noneconomic regulations (e.g., night flight rules, curfews, noise regulations, and air pollution regulations) are being enacted at ever increasing rates, a trend which leads to an expectation of more such regulation in the future. Since these regulations increase the airlines' cost of doing business their enactment must be anticipated and carefully considered when making decisions regarding the acquisition of new aircraft and/or ground equipment. Consequently, the airfreight industry can expect the following:

- The uncertainty associated with noneconomic regulation to make the acquisition of capital for equipment more difficult thereby decreasing the demand.
- Increases in expected indirect and direct operating costs.
- Airlines to request and obtain higher tariffs resulting in volume decreases as determined by the elasticities of demand for airfreight.

Economic Regulations

Economic regulations determine the economic environment in which the carriers provide airfreight service. Eight types of economic regulations, as shown in Table 5-1, are considered: international tariff, international economic, domestic market entry, domestic price, horizontal mergers, vertical mergers, deregulation, and regulatory expectations.

International tariff. - The International Air Transport Association (IATA) was established in 1945. Its principal function is to provide a mechanism to set rates on international routes. IATA has no jurisdiction over capacity or frequency since these matters are handled by bilateral agreement. There are two important provisions in the functioning of IATA: (1) a proposed tariff must be approved unanimously by all members within each conference area, and (2) the proposed tariff must also be approved by the cognizant aeronautical agency of each of the affected member nations.

IATA rates are not always followed since rebating is widespread in the foreign airfreight industry. This practice makes it difficult to define the real rates being paid by shippers on foreign routes. Since IATA membership is not mandatory, not all carriers have chosen to join IATA while others have subsequently chosen to drop IATA affiliation rather than comply with specified practices. Even though the independent airlines are free to set their own tariffs, their proposed tariffs are still subject to the approval of the aeronautical agency of each of the member nations that would be affected. It seems unlikely that a significant number of carriers will leave IATA or that the U.S. international IATA price-setting mechanism will become inoperative.

International economic regulation. - The International Civil Aviation Organization (ICAO, 1927), now a special agency of the United Nations, consists of the Air Navigation Commission, Air Transport Commission, Legal Committee, Committee on Joint Support of Air Navigation Service, and Finance Committee. The Air Navigation Commission has responsibility for developing international air navigation legislation. The Air Transport Commission has responsibility for the economic aspects of international air transport and is actively studying the development of passenger and cargo transport in various regions of the world. Their investigations cover such topics as joint financing of air navigation facilities, airport financing including landing charges, and route facility costing. Presently, the Commission is examining the feasibility of undertaking studies on fares and rates in international air transport. The other committees of the ICAO study various problems of private and public international air law and provide technical assistance to developing nations.

Domestic market entry and price regulation. - Title I. Section 102 of the 1958 Federal Aviation Act (FAA) states, in part; that the CAB "shall consider the following, among other things, as being in the public interest, and in accordance with the public convenience and necessity:

.....

c. The promotion of adequate, economical, and efficient service by air carriers at reasonable charges, without unjust discriminations, undue preferences or advantages, or unfair or destructive competitive practices;

d. Competition to the extent necessary to ensure the sound development of an air transportation system properly adapted to the needs of foreign and domestic commerce of the United States, of the Postal Service, and of the national defense;...."

The CAB derives its economic regulatory powers from Title IV of the 1958 FAA. With respect to international and domestic market entry, Section 401 states that the Board will issue a certificate of public convenience and necessity if it "....finds that the applicant is fit, willing, and able to perform such transportation properly..... and that such transportation is required by the public convenience and necessity....". The Board issued certificates of convenience and necessity to four all-cargo carriers in 1949 (only one is still operating), and two additional all-cargo carriers since 1949. No other certificates affecting all-cargo service have been found to be required by the public convenience and necessity other than those that were issued to the combination carriers under the 1938 "grandfather clause" of the CAA.

Section 403 from Title IV of the 1958 FAA requires that every air carrier file tariffs with the CAB showing all rates and charges for air transportation. Any tariff filed by the carriers can be rejected if it is judged to be inconsistent with the Board's requirements. The carriers must apply the approved tariffs and are not allowed to change tariffs unless they give notice to the Board. Section 404 is intended to guard against discrimination by stipulating that, "no carrier....shall make, give, or cause any undue or unreasonable preference or advantage to any particular person, port, locality, or description of traffic in air transportation in any respect whatsoever...."

Recent issues in airfreight price regulation revolve around charter competition since this type of nonscheduled service is exempt from CAB Regulation with respect to both market entry and price. The resulting competition, both actual and potential, from split charters and shipping associations, threatens to disrupt all-cargo service. For example, although there is a CAB regulation barring two or more groups from going together to charter an airplane, an airfreight forwarder can charter an airplane and then sell space on that airplane to a multiplicity of shippers. Such split charters allow forwarders to charter airplanes when they know they will fill them, leaving the daily service at far less than capacity utilization for the scheduled carriers.

Shipping associations have been formed in some industries to keep transportation tariffs low. In this approach, a group of manufacturers combine to charter an aircraft of the size and to the destination that is mutually desirable. Even though no shipping association has yet chartered aircraft, such charters are a potential threat to scheduled airfreight operations.

Horizontal mergers. - The carriers are not allowed to consolidate or merge their properties unless such actions have been approved by the CAB. Under Title IV, Section 408 of the 1958 FAA, the parties interested in, "... merger...shall present an application to the Board, and thereupon the Board shall notify the persons involved in the...merger...and other persons known to have a substantial interest in the proceedings, of the time and place of a public hearing. Unless, after such hearing, the Board finds that the... merger...will not be consistent with the public interest...it shall by order approve such...merger...upon such terms and conditions as it shall find to be just and reasonable...provided, that the Board shall not approve any... merger...which would result in creating a monopoly or monopolies and thereby restrain competition or jeopardize another air carrier not party to the... merger...", (Reference 5-2). Except for a brief period following World War II, the CAB has rejected most merger proposals.

Vertical mergers. - Mergers between competing modes of transportation promising to provide multimodal service (e.g., motor carriers and airlines) and mergers between airlines and airfreight forwarders are forbidden by CAB regulation. However, if vertical mergers involving airfreight carriers were allowed, then the following could be expected:

- The capital structure of the resulting firms would be more balanced than the airlines are at present. The airlines are very capital intensive while the other firms, especially the forwarders, are more labor intensive.
- The cost and availability of capital might improve. A firm with a more balanced capital structure could be expected to have better access to capital markets.
- Mergers between airlines and airfreight forwarders would result in more efficient terminal space and labor utilization. Airfreight terminals are used primarily at night, and freight forwarder terminals are busier in the daytime. If these could be combined to a single location, then costs would be lowered.

Deregulation. - In 1975, the President transmitted the Aviation Act of 1975 to Congress. It proposed legislation (1) to introduce and foster price competition in the industry, (2) to provide for entry of new airline firms into the industry, (3) to eliminate anticompetitive air carrier agreements, and (4) to ensure that the regulatory system protects consumer interests rather than special industry interests. In 1976, hearings began before the Aviation Subcommittee of the Senate Committee on Commerce regarding the Aviation Act of 1975. The CAB, at that time, suggested open entry, exit, and pricing in the domestic airfreight and air charter transportation industries as well as elimination of CAB jurisdiction over mergers, consolidations, and acquisitions of control. Other proposals to deregulate airfreight include those by Senators Kennedy and Roncalio and by the Department of Transportation (DOT). Table 5-2 (Reference 5-2) summarizes the various deregulation proposals as of April 1977.

TABLE 5-2

COMPARISON OF AVIATION REFORM PROPOSALS

	CAB	DOT	KENNEDY-RONCALIO	ANDERSON-SNYDER	CANNON BILL
Policy	Calls for a phased and progressive transition to an air transportation system which will rely on competitor market forces.	Calls for "maximum reliance" on competition.	Substance same as DOT bill.	Substance same as DOT bill.	Stresses competition but written in terms of a "phased and progressive" transition.
Rates	CAB will control maximum fares for scheduled carriers; minimum fares cannot be "predatory."	Phases out fare restructions until airlines can charge any fare that is not below direct costs.	Phases out fare restrictions until airlines can charge any fare.	Establishes zone of reasonableness for domestic fare and rate flexibility.	Permits rate increases up to 20%; rate decreases cannot be predatory.
Entry	CAB to control expansion of existing carriers route authority and entrance of new air carriers into markets.	Eliminates operating restrictions on existing carriers until they can serve any market as long as they are fit, willing and able.	Eliminates operating restrictions on existing carriers but they must acquire a certificate of fitness. Also provides for establishment of new carriers.	Allows carriers to obtain unused non-stop authority and to expand their route systems on a formula that is point-to-point and air-mile based.	Eliminates all closed door restrictions on existing carriers and all other restrictions that are inconsistent with the new policy
Exit	Carriers can terminate service on 90 days notice, although the Board can defer such action up to 270 days.	Carriers can exit upon 90 days if alternative service is provided; if not, carriers can exit if they cannot cover operating expenses.	Board shall maintain service to "essential points." After four years only requirement for withdrawal is 30 days' notice.	Act makes no new provisions for abandonment of service.	Act makes no new provision for abandonment of service.
Mergers and Intercorner Agreements	Board control over mergers and intercarrier agreements among charters and domestic airfreight carriers is eliminated. Board retains control over scheduled carriers.	Board can only approve mergers if benefits outweigh anticompetitive effects; Board cannot approve agreements to control capacity, fix rates, etc.	Initially Board can approve mergers where necessary but ultimately this authority is transferred to justice department. Anticompetitive agreements are outlawed.	Act makes no new provisions for mergers and intercarrier agreements.	Mergers are placed under anti-trust laws. No special transportation defense is provided.

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TABLE 5-2. - Concluded

COMPARISON OF AVIATION REFORM PROPOSALS

	CAB	DOT	KENNEDY-RONCALIO	ANDERSON-SNYDER	CANNON BILL
Procedural Reform	Procedural standards would be adopted (including time limitations on Board action) but these standards are subject to change.	Board shall hear and decide cases within 10-13 months.	Board shall hear and decide cases within 9 months.	Board shall hear and decide cases within 12 months.	Board shall hear and decide cases within 8 months.
Subsidy	Subsidy program has not been formulated yet. Options include DOT Subsidy Program; Low-Bid Procurement; Simplified Certification; and a contract program of procurement.	Subsidies to be provided to commuters to assure retention of small community service. Presently certificated points eligible for subsidy.	Commuter airlines will be eligible for subsidy. A low bid procurement system will be used to allocate subsidies. Subsidy eligibility based on daily boardings and isolation.	Act makes no provisions for subsidy.	Act makes no provisions provisions for subsidy.
Other	Allows charters to provide scheduled service; aircraft of less than 56 passengers or 16000 lb exempt from economic regulation; deregulates domestic airfreight.	Allows charters to provide scheduled service; aircraft of less than 56 passengers or 16000 lb exempt from economic regulation; deregulates domestic airfreight.	Allows charters to provide scheduled service; aircraft less than 56 passengers or 16000 lb exempt from economic regulation; deregulates domestic airfreight.	Allows charters to provide scheduled service; aircraft of less than 56 passengers or 16000 lb exempt from economic regulation.	Recognizes one-stop-inclusive tour charter statutorily; aircraft of less than 56 passengers or 16000 lb exempt from economic regulation.

With recent publications by academic economists, active participation from consumer groups, support from the DOT, support from combination and all-cargo airlines, extensive lobbying from the supplemental carriers, and proposed legislation from the White House, some level of deregulation of the domestic airfreight industry is probable by the end of 1978. With deregulation, the airfreight industry could expect the following:

- The carriers could compete for traffic on the basis of marketplace determined price service packages. Conceivably, this could lead to a significant increase in the volume of freight shipped by air. The nature of demand would be affected depending on the price and service sensitivities involved.
- The elimination of illegal rebating and elaborate procedures presently used to get around CAB regulations and often used as a poor substitute for price service competition. Such price service competition should result in more favorable conditions for both carriers and shippers.
- The carriers would be relieved of the indirect operating costs associated with regulatory compliance.
- Carrier risk, in the long run, would be reduced through the accommodating of route and tariff changes that would provide for a reasonable rate of return on investment. The resulting market environment would increase carrier demand for capital equipment.

Opponents of deregulation argue that the existing network, while not perfect, has worked reasonably well. They argue that deregulation would result in the following:

- Tariffs would increase due to the present poor airline earnings records since zero economic profit requires more earnings than are presently being earned by the carriers.

- Service quality would deteriorate since "cutthroat competition" would make quality service unprofitable.
- Carrier safety standards would deteriorate since "cutthroat competition" would force the carriers to cut corners that would jeopardize safety.

Much of the basis for deregulation rests with the results of observations concerning the non-CAB-regulated intrastate airlines that offer low passenger fares and earn higher rates of return than the CAB-regulated carriers. Opponents of deregulation argue that this performance is due to low labor costs due to the newness of the carriers and their lack of labor unions, their monopoly positions, and their servicing of only medium-and high-density routes.

Regulatory expectations. - If deregulation was to be enacted, carriers could change routes and the price service package offered to provide the service demanded by the public at a reasonable rate of return. Consequently, deregulation would decrease risk after the initial transition period during which uncertainty might be very high. Airlines could then consider this decreased risk when making new equipment purchases.

- The acquisition of new capital financing for equipment purchases would become easier after an initial transition period during which uncertainty might be very high.

Economic Variables

The effect of economic variables on the airfreight market and the future airfreight system are considered in this subsection. Twelve economic variables are considered: gross national product (GNP), investment, airfreight tariffs, inventory carrying costs, fuel costs, landing fees and taxes, subsidies, mortgaging and leasing, insurance, product life cycles, exchange rates, and wage rate differentials.

GNP. - One of the primary determinants of airfreight demand is GNP. Computed income elasticities of demand for airfreight in the range of 2.5 to 3 (i.e., a percent increase in income will result in a 2.5- to 3-percent increase in airfreight revenue) are not uncommon. Saginor and Richards (Reference 5-4) found the income elasticity of demand for airfreight to be 2.78 using a model based on the years 1946 to 1968 for operations in the continental U.S. Aureille and Norris (Reference 5-5) found the income elasticity of demand for airfreight to be 2.70 using a model based on the years 1951 to 1974 for continental U.S. operations. It is reasonable to expect that the demand for airfreight will remain income elastic in the foreseeable future.

Transportation, as a whole, tends to increase at the same or lesser rate than GNP. For example, between 1947 and 1970, GNP increased 134 percent but intercity ton-miles grew only 89 percent. If 1960 is used as the base, GNP increased 48 percent and intercity ton-miles grew 46 percent (Reference 5-6). A transportation mode has traditionally increased its penetration in the transportation industry during the first 75 or more years of its existence. Consequently, the demand for airfreight can be expected to be income elastic for many years to come.

Some studies have tried to project airfreight traffic and estimate potential airfreight traffic by postulating varying degrees of penetration over time using logistics or Gompertz curves (Reference 5-7). A study based on this type of analysis and published by McDonnell Douglas shows that vigorous growth can continue for several decades due to airfreight's inherent potential (Reference 5-8). This analysis relied on a stage theory of modal growth based on the histories of railroads and trucking.

Investment. - The market value of all goods and services produced in an economy or region (i.e., the market value of consumer, government, investment and export goods produced) is that country's GNP or that region's gross regional product (GRP). If any market is out of line with the other markets, then an effect on the demand for airfreight can be expected. For example, during the construction of the Alaska pipeline, the level of investment in Alaska was disproportionately high. This investment created a demand for emergency spare parts with an attendant demand for airfreight. For this and similar cases the predictions based upon GRP alone would have underestimated the airfreight demand since investment goods have a higher attendant demand for this mode of transport. Consequently, the airfreight industry can expect the following:

- The ratio of investment to GNP has a direct effect on airfreight demand especially as it relates to the emergency market.

<u>Airfreight tariffs</u>. - Like GNP, price is primary determinant of airfreight volume. Unlike GNP, it has not been possible to establish that the price elasticity of demand is either elastic or inelastic. Many studies have found the price elasticity of demand to be in the range from 1.5 to 3 for 10-percent tariff reductions (i.e., a 10-percent decrease in price would increase airfreight volumes by 15 to 30 percent). Saginor and Richards found the price elasticity of demand to be 1.54 (Reference 5-4); Aureille and Norris 1.6 (Reference 5-5), and Eckhard 3.0 (Reference 5-9). Other studies have found the price elasticity of demand to be inelastic (between 1 and 0). Sletmo (Reference 5-10) and Allen and Moses (Reference 5-11) are proponents of this position.

For rate reductions of more than 10 percent, the research to date, though limited and outdated, has found the price elasticity of demand to be high. For example, Boeing found the price elasticity of demand to be 11 for a 50 percent tariff reduction in a 1959 study (Reference 5-12). If a new generation of all-cargo aircraft was to markedly decrease costs and airfreight tariffs, the airfreight industry could expect the following:

- The price elasticity of demand for large tariff reduction (i.e., the relation between the increases in volume and the decreases in tariffs) could be very important. More research is needed on this topic.

- Tariff decreases would increase airfreight volumes with the level of increase depending on the elasticity of demand.

Inventory carrying costs. - Inventory carrying costs are of importance mainly in the divertible sector. To attract divertible freight on the basis of comparative distribution costs, airfreight must produce total cost savings for manufacturers and inform them of these operating economies. The distribution cost trade offs involved in the value of premium air service versus surface-warehouse systems are functionally dependent on the number of days of inventory saved, inventory carrying costs, value/weight ratios, and tariff structures. The Douglas Aircraft Company has developed a computer-based analytical model to aid firms in their computation of these trade offs (i.e., computation of comparative distribution costs, (Reference 5-13).

Total distribution costs are directly related to inventory carrying costs. However, inventory carrying costs are often underestimated. Early literature in logistics management presented yearly inventory carrying costs that were approximately 25 percent of the capital value of each item held in inventory. More current work by Magee (Reference 5-14) and others has shown the inventory carrying cost to be in the range of 35 percent correctly calculated on a marginal opportunity cost basis. The 10-percent difference arises from the earlier literatures neglecting the opportunity cost of capital as a component of the cost of holding inventories and using bank interest rates instead as is illustrated by the following table. These data show the components of inventory carrying costs as a percent of the item value.

Storage	0.25%		
Insurance	0.25		
Taxes	0.50		
Transportation	0.50		
Handling and Distribution	2.50		
Depreciation	5.00		
Obsolescence	10.00		
Opportunity Cost of Capital	16.00	(Interest)	(6%)
	35.00%		25%

The opportunity cost of capital is a very pertinent component of inventory carrying costs. An increase in either the rate of interest or the rate of inflation will increase the perceived and actual opportunity cost of capital. Since airfreight eligibility increases as inventory carrying costs increase, the airfreight industry can expect the following:

- An increase in either the rate of interest or the rate of inflation would increase airfreight volumes.

More important than what is being done in the literature is what is being done by industry. A recent study of six firms by Douglas Lambert (Reference 5-15) found that these firms underestimated inventory carrying costs by an average of 12.4 percent. Although a sample of six firms is not statistically significant, results do suggest that logistics management may be suboptimized in many firms. Consequently, the airfreight industry can expect the following:

- A realization of true inventory carrying costs would undoubtedly have a favorable impact on the growth of the airfreight industry since airfreight eligibility increases as inventory carrying costs increase.

Fuel costs. - The second largest variable cost (i.e., excluding costs such as the cost of capital equipment) in airline operations is the cost of fuel. A 1-cent per gallon increase in the price of fuel costs the U.S. airline industry about $100 million per year. In 1974, the industry's average price of fuel jumped from 12 to 24 cents per gallon resulting in $1.1 billion in additional expenses. Since then fuel costs have continued to increase but at a reduced rate.

The challenge of the "worldwide energy crisis" presents special problems for the fuel-intensive air transport industry. Both price and supply are critical factors with respect to airline operations and economics. The airlines have sought to conserve fuel in the short term through modified operational procedures and service modifications. For example, National Airlines developed and implemented a Fuel Management and Allocation Model that utilized linear programming. The goal was to minimize the effect of price increases and fluctuating allocation levels and to maintain a planned flight schedule. The first month it was used, even though fuel prices increased, National's costs dropped to 14.43 cents per gallon (June 1974) from 16.35 cents per gallon (May 1974) (Reference 5-16).

There is little doubt that the cost and availability of jet fuel will play a predominant role in the future of air transportation. With fuel price increases, both realized and expected, fuel efficiency is playing an ever-increasing role in engine and airframe design.

OPEC, the Middle East oil cartel, has played a major role in oil price increases to date. However, internal OPEC strains and occasional discount sales caused by the present excess supply of oil could seriously weaken or end OPEC.

Airport landing fees and taxes. - All large American airports are owned and administered by some public agency, usually municipal. The tremendous demands for land space for airports, the desire of cities to promote aviation in their areas, and federal aid for construction, have all promoted public ownership. Even with federal aid, public borrowing at low interest rates, exemption from property taxes, and a system of fees and rental charges for services and facilities, most airports find it difficult to meet operating expenses and most airlines find the taxes and landing fees very high.

Many airports have been overbuilt since airport and municipal administrators think, often incorrectly, that they can build magnificent airports for their constituencies at zero cost to them using federal aid and landing fees. Both the federal aid which comes from a tax on airfreight (and passenger services) and the landing fees increase the cost to the user of airfreight (and passenger services) and decrease air carrier profits. This assumes, as is almost certainly the case, the incidence of the tax and landing fees is shared by the air carriers and their customers.

The Airport and Airway Development Act of 1970, as it affects airfreight, imposed a 5-percent tax on airfreight, a $25 per year registration fee on all aircraft, and an annual registration fee of 3.5 cents per pound on all jet aircraft (2 cents per pound on piston aircraft). The proceeds of these taxes go into an "Airport and Airway Trust Fund" to finance planning, development, construction, operation, and maintenance of the airway system and to meet obligations incurred in airport development in accordance with the Act. It has recently been proposed that two-fifths of the 5-percent tax be returned to the airlines to assist in the retrofitting or replacement of aircraft unable to meet FAR 36.

Airport development encompassed by the 1970 Act includes up to 50 percent of airport costs not to include public parking or any part of airport buildings except such as are intended to house facilities or activities directly related to safety of persons at the airport. Among other things, airports obtaining these development funds must establish a system of fees and rental charges for user-oriented services and facilities. The object of these charges is to make airports as self-supporting as possible.

Consistent with the Airport and Airway Development Act of 1970, substantial landing fees based on maximum gross certified landing or take-off weights are collected by American airports. These fees contribute to capital improvements, federal security requirements and operating and maintenance expenses. Since 1970, landing fees have been increasing at an annual rate of 20 percent on domestic flights. During 1976, approximately $280 million in landing fees was collected compared to $14 million in 1957. At present, landing fees comprise 2 to 3 percent of the total outlays of the carriers on domestic flights.

Some carriers have recently challenged landing fee increases. The increases, they contend, are too large and/or intended for the support of inappropriate goals (e.g., airport profit or the support of activities not directly related to airports). It is too early to assess the success of the carriers.

International landing fees, in general, are much higher than domestic landing fees. They comprise 6 to 7 percent of the total outlays of the carriers on international flights. American carriers consider these charges to be excessive and discriminatory. Many foreign airlines and airports are owned and operated by the government, hence high landing fees can be employed to discriminate against the competition. Sample 1976 landing fees and the average rate of increase from 1973 to 1976 for a B707 are presented below, (Reference 5-17):

Country	Average Annual Increase 1973-76	1976 707 Landing Fee
Australia	6.8%	1893
Austria	21.0	1034
Belgium	11.7	996
Denmark	18.0	1008
France	13.5	1000
Germany	14.4	1052
Israel	7.4	724
Netherlands	11.9	943
Sweden	6.2	1228
UK (London-Europe)	7.2	552
(London-Other Int'l.)	6.9	923
U.S. (N.Y. Kennedy)	27.0	1112
U.S.S.R.	37.1	783

If landing fees, both domestic and international, continue to increase as they have in the past, the airfreight industry can expect the following:

- Direct operating costs will increase and the increases will at least partially, be shifted forward to the shippers in the form of higher rates. The resultant impact upon airfreight volumes will depend on the price elasticities of demand.

Subsidies. - In 1949, when certificates of necessity and convenience were first granted to all-cargo carriers, the CAB emphasized that these carriers would not be subsidized. As of the present, no federal subsidies have been or are likely to be given to the airfreight industry.

Mortgaging and leasing. - The present financial position of the American carriers is characterized by high debt/equity ratios. If the market value of leased equipment is considered to be debt, then debt/equity rates of 2:1 are not uncommon in the industry. Presently, much of the equipment is leased, a practice which is often advantageous to both the leasors (mainly insurance companies) and leasees (carriers). The lessors gain the benefit of the investment tax credit (not usable by unprofitable carriers) and title to the equipment (which lowers risk). The lessees gain from lower implicit rates of interest and the ability to obtain equipment. It should be noted that carrier capital and borrowing power limitations severly limit their ability to purchase equipment.

A relatively recent development in aircraft finance is the reemergence of equipment trust certificates. When equipment trust certificates are issued, the vested title to the equipment constitutes loan security, and the time period of the loan is tied to the prospective service life of the equipment. Advantages to the carrier provided by this type of mortgage finance include lower interest rates, applicability of the investment tax credit, and retainment of title.

The Air Transport Corporation (ATC) is another recent development in aircraft finance. Established primarily by former McDonnell Douglas sales officials, ATC proposes to buy used aircraft for cash and lease or sell them back to the carriers. This should help solve the used aircraft problem and provide carriers with additional financing.

Insurance. - In the insuring of large aircraft, the situation faced by the underwriter is the classic one to be avoided, namely, exceptionally limited spread with exposure to catastrophic loss. Aviation insurance rates are established by the individual underwriter using his own judgment of the risk while employing a minimum of assistance from actuarial data. Large amounts of reinsurance are required to spread the risk. Recently, life insurance companies have been participating to a greater extent. However, the majority of American aviation insurance continues to be written by three aviation insurance groups and several companies.

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Product life cycles. - It is possible to hypothesize various future courses of product development, each having its own unique impact upon product life cycle development. As an example, an increase in the rate of technological change would lead to a proliferation of new products with a resultant decrease in product life cycles. A second course of development would originate with an increase in government regulation, either in the form of direct product regulation or increased barriers to entry caused by costly compliance procedures, and could lead to longer product life cycles. It is evident that considerable analysis of future commodity developments is necessary to draw valid conclusions concerning future product life cycles.

Exchange rates. - The value of the U.S. dollar relative to other major world currencies is about 5 percent higher today than it was in 1973 (Reference 5-18). An increase in the value of the U.S. dollar compared to other currencies makes imports less expensive (encourages imports) and exports more expensive (discourages exports). However, everything else has not remained unchanged. The rate of inflation in the U.S. is less than in most other major world economies. The lower rate of inflation in the U.S. makes imports relatively more expensive (discourages imports) and exports relatively less expensive (encourages exports). Relative to U.S. trade, these two effects have tended to cancel one another out. Due to the existence of floating exchange rates between many major world economies, countervailing forces of this type can be expected to keep the exports, imports, and balance of payments of these economies in check during the foreseeable future.

Under a system of floating exchange rates, the currency of a country whose exports are in strong demand (e.g., the German mark, Japanese yen, or Swiss franc at present) increases in value relative to other currencies and tends to bring that country's balance of payments in check. If it did not, the increase in its exports would cause the country to gain a larger and larger balance of payments surplus. The present move toward floating exchange rates will result in the following:

- Floating exchange rates will let market forces determine the value of each currency relative to other currencies and provide an automatic check on each country's balance of payments.
- The system should encourage international trade with its attendant demand for airfreight since market rather than political forces will determine exchange rates and the balance of payments.

Wage rate differentials. - Manufacturing labor costs per unit of output in industrial countries increased at a lower pace, or even declined, during 1976 following the sharp increases in previous years. Continued high rates of unemployment that apparently dampened labor's demand for increases in hourly compensation and sharp increases in labor productivity (that typically occur following the reaching of the trough of a business cycle) accounted for this trend. Japan, Switzerland, and Germany recorded declines as increases in labor productivity more than offset the increases in hourly compensation. France and the U.S. recorded increases of 1.3 and 0.9 percent, respectively, mostly due to sharp increases in labor productivity. However, unit labor increases were substantial in Canada, Italy, and the U.S., ranging from about 9 to 12 percent, as large wage increases outran modest gains in labor productivity.

With unit labor costs increasing 35 percent from 1970 through 1976, the U.S. had the best performance among industrial countries. Germany, with unit labor cost increases of 38 percent, followed. Japan, the UK, and Italy, had unit labor cost increases of 92, 125, and 136 percent during the period respectively (Reference 5-18). A result of this trend is the closing of the gap between the hourly compensation of labor in the U.S. and abroad. If the closing of this gap continues, manufacturing labor costs in the industrialized countries will tend to equalize and comparative advantages based on wage rate differentials will decrease. This would tend to reduce international trade and the attendant demand for airfreight.

Economic and Political Aspects of Competing Modes

The effect of the economic and political aspects of competing modes and the attendant effects on the airfreight market and the future airfreight system are considered in this subsection. Four competing forms of transportation are considered: Federal Express, motor carriers, railroads, and water carriers.

Federal Express. - Federal Express provides overnight delivery of small packages utilizing the hub spoke concept with the hub located at Memphis, Tennessee. To provide this service, Federal Express uses Dassault Falcon fanjets with a 3410-kg payload. Since their aircraft are small, under 5680 kg maximum certified takeoff weight, Part 298 of the CAB's Economic Regulations designates Federal Express as an "air taxi operator" exempt from regulation.

Since its 1973 inception, Federal Express has grown rapidly. For the year ended May 1977, Federal Express earned approximately $8 million on $110 million in revenue. They move approximately 25 000 shipments per day at an average cost of $20 per shipment using 41 aircraft, 500 vehicles and 2200 employees.

At present, the CAB air taxi size limitations prevent the use of larger aircraft. During 1975, Federal Express petitioned the CAB for an exemption to operate five DC-9 aircraft. Their request was denied on the grounds that a Certificate of Public Convenience and Necessity is necessary for an exemption of that scope. Subsequently, Federal Express unsuccessfully appealed to Congress for relief, is presently supporting airfreight deregulation, and has applied to the CAB (3/77) for a Certificate of Public Convenience and Necessity to expand service to nearly 250 cities and to connect any two cities in the system without route restrictions.

Even though much of the Federal Express traffic constitutes market expansion, some of their traffic is a substitute for emergency prime-time all-cargo service. Consequently, the airfreight industry can expect the following:

- Any expansion of Federal Express or similar operations in the future will detract from the emergency airfreight market available to the scheduled carriers.

Motor carriers. - Interstate Commerce Commission data shows that, excluding pipelines, the motor carrier industry transported 29.1 percent of the total domestic intercity freight transported in 1974. The structure of the motor carrier industry from an ecopolitical viewpoint is presented in Table 5-3. These data in parentheses also illustrate the characteristics of the Motor Carrier Reform Act currently being considered by the Senate.

Antideregulation forces, headed by union officers, argue that deregulation would benefit the large customer, increase rate uncertainty, leave smaller towns and firms without service, and require subsidization of service to small towns and firms. Those in favor of deregulation argue that rates would decline from 7 to 20 percent (rate reductions are not denied by the antideregulation forces). With respect to motor carrier price reduction, the airfreight industry can expect the following:

- Since general commodity common carriers are the air carriers' most direct competitors, any decrease in their rates would have an effect upon airfreight volumes. The magnitude of this effect would depend upon the price elasticity of demand by commodity type.

Rail carriers. - The Interstate Commerce Commission data show that, excluding pipelines, railroads transported 47.7 percent of domestic intercity freight in 1976. The rail share has been decreasing over time amounting to 65.1 percent in 1950, 54.0 percent in 1960, 51.2 percent in 1970, and 50.5 percent in 1974. In an attempt to revitalize this energy-efficient form of transportation the Railroad Revitalization and Regulatory Reform Act (4R Act) of 1976 was enacted February 5, 1976. The present structure of the railroad industry and the major changes brought about by the "4R" Act will be discussed

TABLE 5-3

MOTOR CARRIER INDUSTRY STRUCTURE

Type of Carrier	Specialized Commodity	General Commodity	Regulated Contract Carriers	Private Carriers	Agricultural Carriers
Routes	Regulated (Motor Carrier Reform Act lessens regulation.)	Closely regulated. Specific routes and stops are often stated. (Motor Carrier Reform Act lessens restrictions and allows carriers to use most direct route.)	Not regulated.	Not regulated.	Not regulated.
Services Provided For	General Public		Up to 7 firms (MCRA removes number of firms restriction.)	Company divisions only (MCRA allows for subsidiary inclusion.)	Exempt agriculture commodities.
Commodities Carried	Closely regulated (MCRA would remove most regulation.)	Regulated, loosely (MCRA would remove most regulation.)	Regulated, loosely (MCRA would remove most regulation.)	Not regulated.	Unprocessed agricultural commodities.
Setting of Rates	Set by general vote of member carriers operating through the "Rate Bureau." Subject to suspension and review by the ICC. Not subject to antitrust regulation. (MCRA: Set by individual carriers within a nonpredatory zone of reasonableness. Rates outside the zone are subject to ICC review. All rates subject to antitrust regulation.)			Not regulated.	Not regulated.
Percent of Ton Miles	← 40 →			← 60 →	
Entry	Closely regulated. Most carriers entered under a 1935 grandfather clause. (MCRA: Fit willing and able applicants who propose reasonable rates must be allowed entry.)			Not regulated.	Not regulated.
Shipment Size	Primarily truckload	Primarily less than truckload	Primarily truckload	Primarily truckload	Primarily truckload
Backhauls				May not lease to common carriers. May not haul for subsidiaries. (MCRA: May lease to common carriers. May transport for subsidiaries.)	Not permitted (MCRA firms with 3 or less trucks may compete with common carriers for backhauls. They must charge common carrier prices.
Mergers	Under ICC control. (MCRA: Not under ICC control. Different types of regulated carriers may merge subject to antitrust regulation.)	Under ICC control.	Under ICC control	Not permitted.	Not regulated.

from the standpoints of tariffs, rates, mergers and consolidations, subsidies, and work rules.

Tariffs: A structure of class and commodity rates exist that are a function of a multiplicity of factors. More than 80 percent of the total rail freight charges are based on the 43 trillion commodity rates on file with the ICC (Reference 5-19). The "4R" Act allows rail carriers freedom to raise or lower rates up to 7 percent per year for 2 years, and to file a new rate whenever it would require a capital expenditure of $1 million or more with a minimum of ICC interference.

Rate making: Prior to the "4R" Act, the process for setting a rail rate was usually initiated by a rail carrier who submitted the proposed rate to the corresponding freight bureau. The freight bureau, consisting of a consortium of carriers, reviewed the proposed rate and conducted hearings regarding its acceptability to both intramodal and intermodal competitors and shippers. When approved, the bureau published the proposed rate and forwarded it to the ICC. Once approved and published, the rate became effective in 30 days unless suspended by the ICC. The "4R" Act prohibits rate bureau discussions or voting on single line rates and also on joint line movements when a carrier is not a participant (i.e., the "4R" Act prohibits cartelization and changes the function of the freight bureau to publisher of rates). The Act also limits the time allowed the ICC to decide rate cases.

Mergers and consolidations: The "4R" Act liberalized mergers and consolidations, and provided $2.1 billion in government financing to establish Conrail from six bankrupt Northeast railroads.

Subsidies: The "4R" Act made the following money available for railroad rehabilitation:

- $6.5 billion to Conrail over a 10-year period.
- $360 million for a 5-year program of subsidies to maintain service over essential but deficit branch lines.
- $1.7 billion for upgrading of the AMTRAK Washington-New York-Boston corridor.

- $1 billion in government loan quarantees to railroads at large for plant and equipment.
- $600 million in government financing for rehabilitation of track and other fixtures.

Work rules: The railroads are hampered by outmoded work rules. The railroads, in an effort to modernize, are pushing for three basic work rule changes in their 1978 union labor contracts:

- The present rules regarding crew makeup requires almost every road train and yard assignment to be manned by a conductor and two brakemen. The railroads are arguing that a crew of three plus engineer is not needed.
- As a basis for pay, present rules state that 100 miles or 8 hours correspond to one day's work. The railroads are arguing for a straight hour basis of pay.
- Present road crews perform either yard or switching work, not both. The railroads are arguing for the performance of both yard and switching work by road crews.

The future competitive position of the railroads will depend upon the success of the "4R" Act and Conrail, rail yard modernization, work rule changes, and the effective application of containerization.

Water carriers. - Shipping is by far the most important form of transportation between countries separated by water. The present structure of this industry (Reference 5-20) is discussed below.

Rates: Ocean carriers have organized themselves into groups called steamship conferences to stabilize rates and other conditions in the industry. As an example, these conferences set commodity rates by agreement using a two-rate system. Shippers promising to use only conference members during a specific period of time are charged as much as 15 percent less than other shippers. This cartel form of rate setting is legal in the U.S. since the Shipping Act of 1916 exempted shipping conferences from U.S. antitrust statutes and the Federal Maritime Commission (FMC) has only limited authority over the rates set. The Commission may not disapprove rates unless they are so unreasonably high or low as to be detrimental to U.S. commerce, unjustly discriminatory between shippers or ports, or unjustly prejudicial to U.S. versus foreign exporters. The FMC has rarely used its authority.

Not all ship lines belong to a shipping conference and those that do not are unregulated. As an example, in the Far East many shipping lines have left the conferences in an attempt to compete with the Russian carrier (Fesca-Lines) which is discounting rates as much as 30 percent. A large portion of ocean-going freight is presently containerized, especially in the North Atlantic. Shipping conferences are continuing to establish commodity instead of container rates; however, the move toward containerization will probably force the shipping conferences to adopt container rates in the future.

Rebating: The FMC requires steamship conferences to expel members found guilty of rebating. However, the policing of this practice is very difficult, and rebating is rampant in the industry. The FY1978 FMC subsidy to the industry requires all shipping lines receiving an operating differential subsidy to cooperate with the FTC's investigation of illegal rebating.

Entry: Under federal maritime law, entry to shipping conferences, and hence the industry, is open to all ship lines.

Subsidies: Subsidies amounting to $553 million have been approved for FY1978 for administration by the FMC. This is $105 million more than the corresponding FY1977 sum and $5 million more than congress was originally requested to approve. A major portion of the 1978 funding is directed to operations and ship construction with lesser amounts going for research, reserve fuel, the academy, and maritime schools.

Tolls: Tolls are collected from users of inland U.S. waterways and the St. Lawrence Seaway. Canada recently tried to double St. Lawrence Seaway tolls, but the U.S. rejected this plan and a compromise is being considered. It has been postulated that a doubling of St. Lawrence Seaway tolls would reduce traffic 30 to 50 percent.

Technology: Intermodal containerization with its added safety and convenience is being adopted by the ocean carriers. Three forms of intermodal containerization need to be considered: Mini-Bridge, LASH and Seabee, and sea-air Mini-Bridge are utilized to reduce water transit time. When applied, one rate is charged by the ocean carrier for the entire shipment and compensation is made to the railroads by the water carriers. The application of this concept has resulted in a shift of sea freight from Eastern and Gulf ports to West Coast ports. With the LASH and Seabee systems, remotely loaded barges are taken aboard and transported by the mother ship. These concepts reduce port time and are particularly applicable where container loading cranes are limited or not available. Sea-Air involves the use of containers compatible with both the air and sea modes. The most important problems associated with this concept involve tare weight, port time, and customs procedures.

Shippers' councils: These councils are created by a multiplicity of ocean carrier customers who join together to pursue their common interests. Such councils are a recent development of having their greatest impact in trade between foreign countries. Their legality under present U.S. antitrust law is uncertain with respect to trade involving the U.S.

The primary interaction between the sea and airfreight markets will occur primarily as a result of changes in rates. If the integrated result of technical and ecopolitical changes in the sea transport industry is a net reduction in tariffs, then the potential diversion to air will be reduced and the capture of divertible cargo made more difficult.

Civil Reserve Air Fleet (CRAF)

The Civil Reserve Air Fleet (CRAF) is an integral part of the National Transportation Plan's standby programs and procedures for emergencies. Established by Executive Order No. 10999 in 1952, the plan requires the Office of Emergency Transportation of the Department of Commerce to allocate to the Department of Defense (DOD) specific aircraft, with designated capabilities, for use in direct support of the military airlift needs. The DOD, working with the nation's airlines, arranges for a contractual release of the CRAF aircraft for emergency service. To help develop the program, military airlift contracts are awarded only to those civil airlines that are members of CRAF. The civil carriers are thus encouraged to procure modern aircraft suitable for military use in emergencies.

Responsibilities for implementation of CRAF. - The Director of the Office of Emergency Transportation is the action agent for the Department of Commerce and has the responsibility for developing plans to utilize the air carrier civil air transportation capacity and equipment, both domestically and internationally. Such action would occur in a national emergency, particularly in areas concerned with: (a) Obtaining and analyzing Department of Defense, Civil Aeronautics Board, and other agency requirements for the services of air carrier aircraft to provide for essential military and civilian use; (b) allocation of air carrier aircraft to meet the needs of the DOD for military operations and the CAB for essential civilian needs; and (c) providing aviation war risk insurance coverage as appropriate.

The Assistant Secretary of Defense (Installations and Logistics) is the action agent for the DOD in matters related to airlift requirements and policy coordination. He serves as the primary DOD point of contact with the Office of Emergency Transportation on all matters relating to: (a) all operational planning in connection with the use of CRAF aircraft that are preallocated or allocated by the Office of Emergency Transportation, DOC; (b) determining suitability of aircraft for allocation; (c) exercising operational control over allocated CRAF airlift resources; (d) contractual relationships with air carriers.

The Director of the Office of Emergency Transportation and the Executive Director of the Single Manager Operation Agency for Airlift Service (Commander MAC) collaborate and coordinate on all decisions relating to CRAF allocations. Subsequently, the aforementioned Executive Director (Commander MAC) has the responsibility of keeping the Director of the Office of Emergency Transportation advised in the following areas: (a) the status of contracts or other arrangements for use of CRAF resources; (b) the number of aircraft by carrier, type, and registration number, committed within the respective stages of peacetime contracts; (c) the number of aircraft by carrier type and registration number that are activated under a given airlift emergency and utilized under the terms of the peacetime contracts; and (d) the number of CRAF aircraft available for other employment based on current military requirements.

How the CRAF fleet has changed. - At the start of the program, the CRAF fleet consisted only of propeller-driven aircraft. As the civil airlines began to acquire jet aircraft, the composition of the CRAF fleet began to reflect this new level of technology as noted below.

Aircraft Type	Number of Aircraft		
	1965	1970	1977
International Cargo			
Piston	85	0	0
Jet	55	196	133
Domestic Cargo			
Piston	83	33	0
Jet	0	19	41
International Passenger			
Piston	0	0	0
Jet	120	175	98

By 1970, the annual lift capability of the CRAF fleet had grown to 206 million passenger-kilometers and 29 million tonne-kilometers.

Variations in the use of this CRAF capability by the military can be measured by the value of the contracts with the commercial carriers as summarized below.

Fiscal Year	$ Million	Fiscal Year	$ Million
1963	254.0	1971	539.0
1964	238.3	1972	531.6
1965	277.3	1973	363.7
1966	438.6	1974	271.5
1967	734.3	1975	352.8
1968	743.0	1976	282.9
1969	669.5	1977	294.4
1970	608.5	1978	170.0

While the dramatic reduction in CRAF contracts can be related to the resolution of the Viet Nam situation, the relatively lower monetary value of these CRAF contracts during recent years was caused by two additional factors. These factors are, first, efforts of the DOD to reduce expenses by increasing the use of the Military Airlift Command (MAC) aircraft for peacetime lift, and second, the nature of outsized military equipment precludes its carriage by aircraft in most of CRAF. A recent study of the 1977 CRAF shows that while available airlift accounts for approximately 50 percent of total passenger and cargo airlift requirement, its cargo lift can account for only 35 percent of the requirement. This 35-percent cargo capability is further defined as 74 percent bulk capability and only 25 percent to carry oversize military goods. This compares with a daily airlift requirement of 23 percent bulk, 53 percent oversize, and 24 percent outsize cargo. These classes of military cargo are defined as follows:

- Bulk cargo - That which is within the usable dimensions of a 463L pallet (2.64 x 2.13 meters) and of a height established by the cargo envelope of the particular model aircraft. For military aircraft, the maximum height is 2.44 meters.
- Oversize cargo - A single item that exceeds the usable dimensions of a 463L pallet but is smaller than outsize cargo.
- Outsize cargo - A single item whose dimensions exceed 20.6 x 2.97 x 2.7 meters.

The crux of the problem rests with the fact that 74 percent of the CRAF cargo fleet is restricted to bulk capability. Several possibilities for solving this short-fall in airlift are currently under study, as follows:

Implementation of/or modification to,

a. C-5A - aerial refueling
b. C-5A - replace certain wing sections
c. C-141 - stretch fuselage and install aerial refueling
d. C-130 - replace with AMST transports
e. KC-135 - replace with advance tanker cargo transport (AMST)

Modification of CRAF wide body aircraft,

a. MINI - MOD - addition of a nose cargo door and a cargo floor treadway system
b. MAXI - MOD - addition of a side cargo door and a complete freighter floor

If none of the above enhancements or modifications are carried out, a minimum of 165 C-5As or equivalent would be needed to meet the airlift requirements.

In a broader sense, the national interest may well be better served with the development and production of the so-called CX-X transport. With such airlift included in the CRAF fleet, the short-fall in military airlift could be resolved and the civil fleet could update its capability to meet the need for oversize or outsize commercial shipments.

SECTION 6

FUTURE POTENTIAL MARKET AREAS

Growth in the future air cargo market will be realized through expansion of the overall freight movement due to growing trade, the diversion of cargo movements from the surface modes to the air mode, and/or through the creation of new markets. These new markets may occur in terms of geographical areas, new industry, or new products. For the sake of discussion new market sources will be considered to include regions, countries, and areas of the world, possessing a higher than normal growth potential. More appropriately, such sources of possible growth will be identified as emerging markets.

Analysis of the current air cargo system has led to the identification of various market areas that represent potential sources for future air cargo expansion. Discussions of these potential growth areas along with the rationale leading to their identification are categorized under World Freight Movement, Emerging Markets, and Airfreight Penetration.

World Freight Movement

There has been a continuous growth in world trade amounting to an average annual growth rate of 9 percent (Reference 6-1) over the past decade. A review of data provided by the United Nations (UN) and the Transportation Association of America (TAA) indicates that the associated total world freight movement is 64 percent international and 36 percent domestic. Looking more closely at the international movement, (Reference 6-1), shows that 60 percent takes place between developed regions of the world, namely, North America, Western Europe, Japan and the Centrally Planned Economies. Trade between these regions and the developing regions of Africa, Middle East, Latin America, and the rest of Asia and the Pacific, comprises 35 percent of the total. Trade between the latter developing regions provides the remaining 5 percent of the world's total freight movement.

There is considerable conjecture on the future growth in world trade. An average annual growth in revenue tonne-kilometers of 4.5 percent, indicated by the UN and TAA data, appears compatible with the gross national product and productivity forecasts for developed countries (References 6-1 through 6-3). As in the past, the characteristics of the commodities encompassed within this trade are expected to change. As an example, in the last two decades the importance of manufactured goods, based on value, has increased from 41 percent of the total movement in 1950 to 64 percent in 1973 (Reference 6-1). With appropriate allowances for inflation and the increase in oil prices beginning in 1973, this trend is evidenced in the increasing value of trade shown in Figure 6-1. Prior to 1973 (Reference 6-4), the combined inflation rate for the 24 Organization for Economic Cooperation and Development (OECD) countries was running around 6 percent.

A considered rationalization of the forecast trends (References 6-5 through 6-15) leads to the conclusion that the growth in manufactured goods will continue well into the next decade. The following changes are illustrative of the anticipated trends that substantiate this conclusion:

- Early 1980s will see developed countries well into the "post-industrial" era where recycling will develop in importance.
- There will be continued growth of multinational corporations particularly in the developing economies.
- The absolute growth of many under- and less-developed (UD and LD) countries will be sufficient to increase the demand for higher value manufactured goods.
- As the cost of labor increases, industry will become more capital intensive and assembly industries will shift to areas having cheaper labor.
- Increasing levels of consumer discretionary spending through 1990.

It is estimated that the value of manufactured goods will increase at an average annual rate of 1 to 2 percent relative to the total world freight movement.

The preceding data give brief evidence of the existence of two potential sources of air cargo growth within the world's future total freight movement. First, assuming the air share remains constant, any increase in

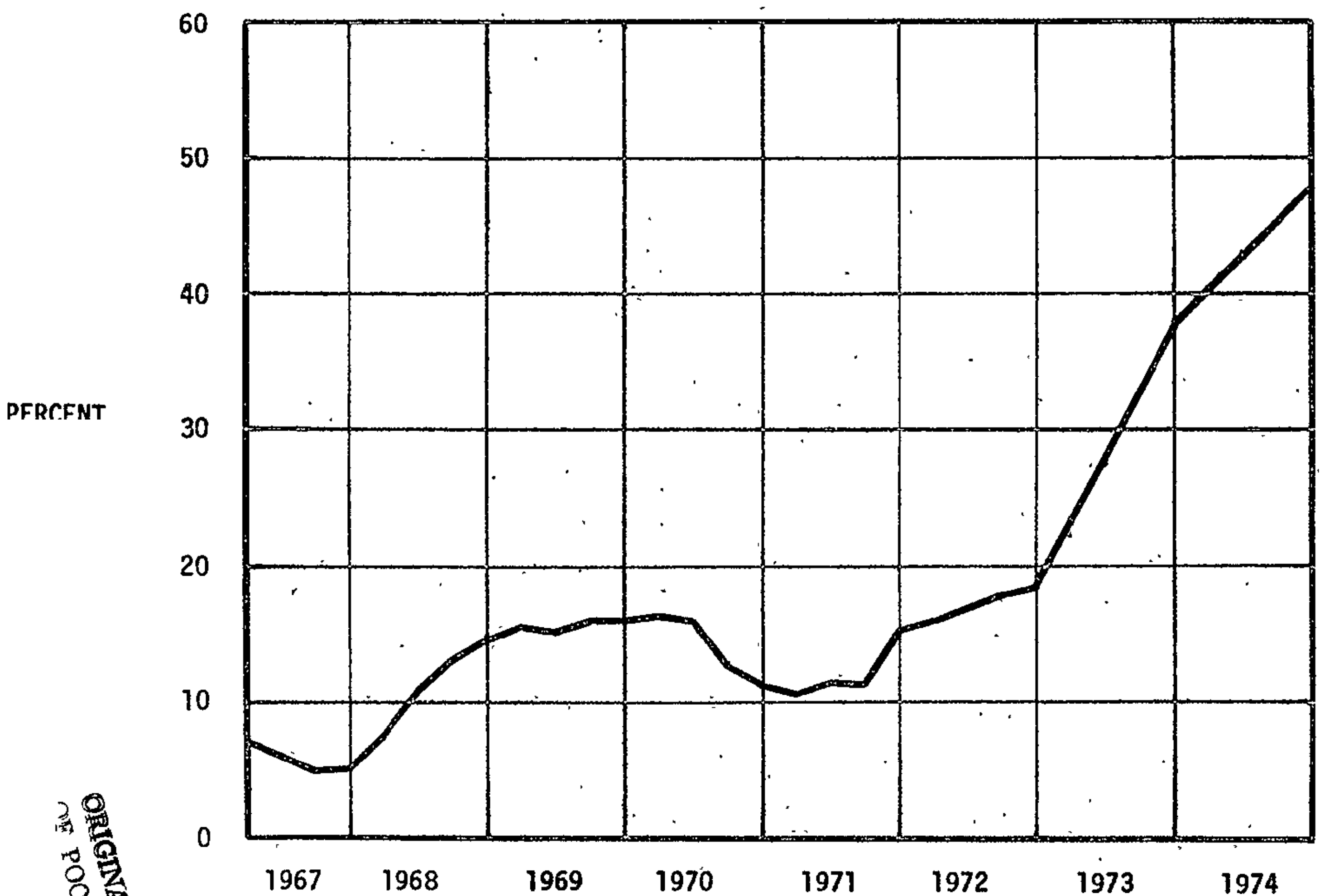

Figure 6-1. Growth of World Trade

world trade should result in a proportional growth in the volume of air cargo. The second source of potential growth will originate within the increases in volume and/or value of manufactured goods being traded. Manufactured goods are generally of higher density and value; both these characteristics are attributes associated with air eligibility. Therefore, any growth in the volume of this higher value freight should result in a proportional increase in the quantity moved by air. On the other hand, an increase in the value of products already contained within a given market should, in a like manner, provide a compatible improvement in the potential for air penetration.

Emerging Markets

Between now and 1990 there will be many social, political, economic, physical, and technological changes occurring that will affect the course of world trade. The following items are the result of an integrated analysis of the forecasts contained in References 6-5 through 6-15, and as such they illustrate the types of change that must be considered.

- Continuing improvement in standard of living around the world. Substantial relative improvement will be achieved by UD and LD countries having raw material, a stable government, and favorable social conditions.
- By 2000, 90 percent of the U.S. population will be in urban areas with approximately half residing in the South and West.
- There will be some grouping of LD countries by regions to promote economic influence.
- World economic interdependence will become evident to even the most underdeveloped nations.
- Strong U.S. involvement in technology assistance, foreign aid, and economic development programs for the LD countries.
- Growing dependence of industrial countries on mineral imports.
- U.S. manufacturing will continue to decentralize; driven by resources, surface transportation, and labor availability and cost.
- Increasing levels of industrial technology through year 2000.

- Growing trend by LD countries to develop necessary processing and manufacturing capabilities in lieu of exporting raw resources.
- The growth of trade between developing economies and the industrial nations will be higher than the growth between the industrial nations.

Three factors, energy, labor, and industrialization, appear to permeate through these and other changes having a potential to affect future trade patterns. The specific interactions with trade are difficult to define since the three factors are closely interrelated and each encompasses a multiplicity of highly dependent considerations.

The developing world situation on energy will impact not only transportation but also the distribution of population and industry at both the inter- and intranational levels. The availability of fossil fuels, combined with the growing world interest in the ecology, places emphasis on areas containing nuclear and/or hydroelectric related resources.

The availability of labor, in terms of number and skills, is a pertinent issue in both developed and underdeveloped countries of the world. Closely akin to availability are the considerations of labor cost and productivity. Potential solutions rest with the possibilities of moving industries and/or labor in a manner compatible with desired growth. It is expected that both these actions will be taken in the future to achieve productive utilization of manpower. It should be noted that for less-developed areas the exporting of labor provides an effective means of reducing an unfavorable balance of payments.

In addition to energy and labor there are many ecopolitical influences that will determine the future location and relocation of industry. Not the least of these influences will be the expected growth of multinational corporations. These organizations will be especially effective in accelerating the growth of desirable UD and LD regions. Multinations, in combination with the assist supplied by developed countries, will provide the means for such regions to take advantage of the current state of the art. In the developed countries, the anticipated shift from production to service, combined with the increasing cost of labor and materials, will exert a strong influence upon the relocation of some industries in less-developed regions. Likely candidates for movement are high-polluting and/or low-skill manufacturing or assembly processes. Regardless of the reason, any such shifts in the distribution of industry should result in an increase in higher value freight.

The preceding discussion briefly outlines the rationale employed in identifying the more prominent of the emerging markets. This rationale was developed during the course of investigating the current freight market and transportation network and resulted in the identification of the emerging regions shown in Figure 6-2. These five regions, one domestic and four international, appear to be the more promising of the world's potential growth areas.

Domestic. - Energy, environment, and labor appear as the prime reasons underlying the current opinions regarding the future growth of the southern portion of the U.S. While there has been some industrial activity in this region, the greatest substantiation of this potential rests in the future-oriented development planning being accomplished by cities and states in this region. Examples of this activity are the Atlanta plan to the year 2000 and the State of Arizona Solar Energy Research Commission. The CAB has just recently identified the Atlanta, Dallas-Forth Worth, New Orleans, and Tampa airports as new gateways to Europe. In addition, the Bermuda II agreement identifies Houston as a gateway to London.

International. - Each of the international regions, South America, West-Central Africa, Middle East, and Far East, encompass a multiplicity of countries having characteristics compatible with future growth. To illustrate this point and to facilitate subsequent analysis, a limited number of countries were singled out for in-depth viewing. The selected countries are identified in Figure 6-2. With the exception of Brazil, Indonesia, and Bolivia, these countries are forecast to be among those having the 15 highest forecast GNP growth rates prior to 1990 and a current growth rate of at least 6 percent. Brazil and Indonesia were selected to be compatible with the United Technologies study of developing countries, (Reference 6-16). Bolivia, on the other hand, was chosen because of its landlocked position and, while not in

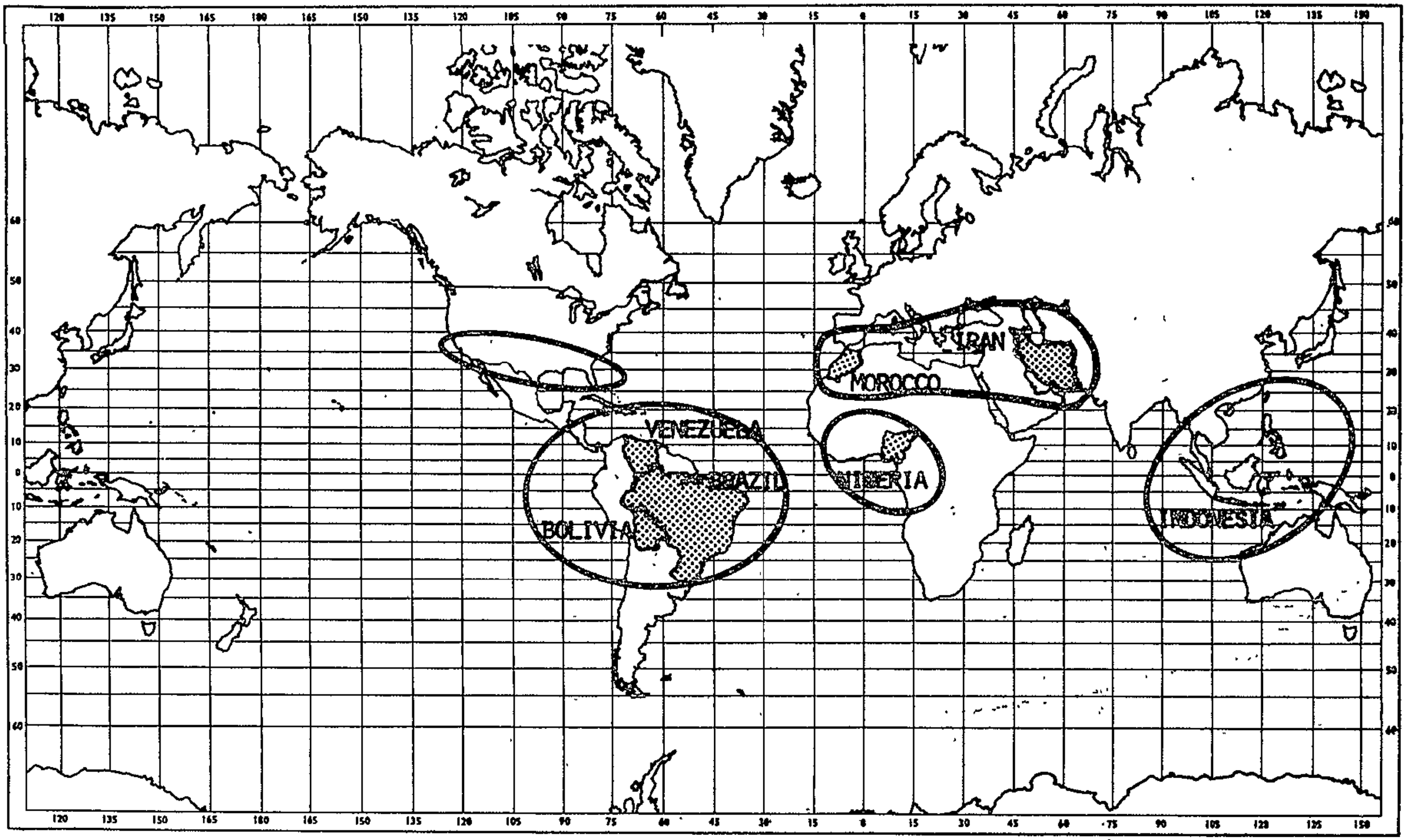

Figure 6-2. Emerging Markets

the top 15 growth countries, it does have a forecast GNP average growth rate of 5 percent.

The future growth of airfreight associated with a given country is a function of that country's expected trade expansion, which in turn is dependent on the social, political, economic, physical, and technological developments that occur within its boundaries. However, rate and scope of this internal development is very strongly affected by conditions existing in the world's total environment. A realistic forecast of future airfreight growth requires, therefore, a detailed investigation of the potential future developments and changes expected to occur within the total environment of the considered country as related to world conditions. Data pertinent to these analyses are contained in a multiplicity of documents as illustrated by References 6-17 through 6-33.

The future outlooks for Venezuela, Bolivia, Morocco, Iran, and Nigeria are outlined in Tables 6-1 through 6-5. These data are the result of an integrated analysis of the data contained in References 6-17 through 6-33 and illustrate the emerging potential of the respective countries. Factors that these five countries have in common are: a relatively stable sociopolitical future, resources important to postindustrial economies, realistic plans for industrial/agricultural development and diversification, and labor forces that are adequate in number but deficient in skills. Excluding current industrial and socialist countries, the data of Reference 6-34 show Indonesia, Brazil, Nigeria, and Iran, falling within the top 11 most populated countries by year 2000.

Bolivia, in its landlocked position, illustrates a unique future challenge to the airfreight industry. With its high ratio of resources to population, Bolivia has the potential for rapid growth. Undoubtly, its landlocked position has been a handicap to this development in the past. The challenge to the airfreight industry thereby rests on the need for this industry to establish and implement an integrated industrial and air transport development plan for Bolivia. The synergistic effects of such cooperative effort between transportation and industry would accelerate that country's development and provide a growth in airfreight volume that would

TABLE 6-1

OUTLOOK FOR VENEZUELA

- Increasing export of non-oil products
- Delicate relations with U.S. as affected by oil situation, accounts for 30 percent U.S. oil imports.
- Oil situation: Member of OPEC
  Industry nationalized in 1975
  Exports will drop over 4 percent per year
  Oil revenue has passed peak
  Surplus balance of payments
- Forming "Association of Iron Ore Exporting Countries" with countries accounting for over 1/2 world exports.
- Five year plan 1975-1979: Real average annual GNP growth of 8 percent
  Manufacturing output increase 15 percent per year
  Imports to increase 14 percent per year
  Small aircraft, helicopter production by 1979
  Expansion of rail system
- Emphasis on: Industrial development and diversification:
  Increase agriculture
  Socioeconomic problems, i.e., unbalanced income
- By 1985, 90 percent of assembled vehicles to be locally produced, or an equal quantity of locally produced parts must be exported.
- Continuing growth in nontraditional exports.
- Action taken: Diversion of revenue to investment
  Restrained public expenditure
  Tax credit to stimulate nontraditional export
- Leader in move to create new Latin America economic organization, SELA, alternate to Organization for American States (OAS)

TABLE 6-2

OUTLOOK FOR BOLIVIA

- "Potential for rapid and equitable economic growth" world bank.
- Ratio of resources/population among highest in world.
- Inflation should remain below 6 percent.
- At present production, known petroleum reserves will be depleted in 9 years.
- Real economic growth will remain at about 5 - 6 percent.
- Areas of future economic growth: agriculture and cattle
diversified mining
- Trade deficit at least until 1978.
- Planned industrial development.
- Mineral deposits, include: uranium, tin, lead, zinc, gold, silver, antimony, tungsten.
- Industrial development criteria: profitability
use of domestic raw materials
export potential
- Steady gain in exports - around 15 percent in 1976.
- Attempt to hold imports at 1975 level until trade deficit corrected.

otherwise not be achieved. Similar situations exist with other countries less fortunate than Bolivia. While the expected growth in these cases may not be as large, there could be interrelated results that would contribute to the solution of future network and/or back-haul problems.

Airfreight Penetration

The commodity networks of Section 1 identify commodities where value and quantity moved make them likely candidates for shipment by airfreight. In addition to the limited number shown for illustrative purposes, there are dozens of other commodities of lesser import, relative to value and/or quantity, that are equally susceptible to diversion from surface to air.

TABLE 6-3

OUTLOOK FOR MOROCCO

- Government investment related to phosphate.
- Export trade based primarily on phosphate - 34 percent of world's resources.
- Payments surplus is expected to continue.
- Emphasis on regional development: public works
  agriculture
- Nationalized oil distribution system.
- Rich agricultural resources - citrus and vegetables for Europe.
- Association with EEC on future trade and aid.
- Financing arrangements with OPEC countries.
- Moroccanization of foreign investment has slowed foreign investment.
- Annual average real GNP growth of about 2.5 percent expected.
- Five year plan includes: improved meat production
  growing/processing fruits and vegetables
  light manufacturing for export
- Mineral deposits include: lead, zinc, silver, antimony, maganese, cobalt.

Comparing the freight moved by air and sea, it becomes evident that in many cases equal or greater quantities of similar commodities are moving by sea. For example, (see Table 1-98), 387 tonnes of Parts, Office Machinery (SITC 71492) move by air from Los Angeles to Japan while another 296 tonnes were moved by sea. However, the average product value is 39 percent lower for the latter. The question is, therefore, "Why doesn't more of this type freight move by air?" The answer lies in the mode selection process applied by the shipper and as affected by his approach, his knowledge, and his pre-emptive concepts. If one is considering a specific product, then the mode choice can be addressed through personal contact. However, the problem of identifying potential airfreight is considerably more difficult when addressing commodity networks where the origins and destinations are countries and/or regions of the world.

TABLE 6-4

OUTLOOK FOR IRAN

- Favorable sociopolitical situation
- Cautious international relations with: USSR
  Arabian Nations
  Iraq
  Afghanistan
- Lack of managerial talent in government is disruptive
- Economic growth slowed due to reduced oil production
- Continuing growth of industry particularly in: Vehicles
  Metals
  Household appliances
  Construction
  Services
- Real GNP annual growth rate of about 8 percent
- Inflation will remain at 10-15 percent level for several years
- Limits on foreign equity and antiprofiteering measures are temporarily destabilizing
- Increasing private consumption
- Reducing exports and increasing imports in both private and public sector with former predominating
- Current development plan stretched 1-1/2 years
- Twenty-year energy development plan utilizing natural gas, hydroelectric and nuclear
- Rich uranium deposits discovered
- Mineral deposits include: lead, zinc, chrome, manganese
- Joint venture with Australia on dairy and meat production
- Very large surcharges resulting from delays in ship unloading favorable to air cargo expansion

TABLE 6-5

OUTLOOK FOR NIGERIA

- Political situation appears stabilized - phasing into civil government by October 1979.
- Currently oil represents 91 percent of exports and 45.5 percent of GNP
- Inflation will remain greater than 30 percent at least through 1977 - prime causes: inadequate domestic production
  overloaded distribution system
  excessive wage increases
  enormous consumer demand
  huge development spending
- Highest paid work force in Africa
- Third development plan (1975-1980) calls for spending $\$50 \times 10^9$ with emphasis on: infrastructure
  social services
  manufacturing
  agriculture
- Trade surplus down due to reduced oil shipment.
- Facilities under construction should result in increased oil income in early 1980s.
- Industrial production (non-oil) should regain modest growth during 1977.
- Continuing growth of imports, rate determined by oil prices.
- Port congestion being reduced but will remain a consideration.
- Average annual growth of real GNP expected to be about 7 percent through mid-1980s.

Distribution cost approach to divertible commodities. - One approach to identifying the surface-to-air diversion potential of a given international commodity network is to look at the associated total distribution cost at the macro level. While such analysis is sound, there is no assurance that the identified potential will be realized. In the real world, the opinions of the decision makers combine with industry and market uncertainties in a manner that places the input variable on an insecure base. Variations in several of these analysis variables, either singly or in combination, can have a measurable effect upon the level of the resulting airfreight potential.

The Los Angeles to Japan commodity network will be utilized as the vehicle for illustrating the use of the total distribution concept (TDC) to identify the airfreight potential. As previously noted, the data of Table 1-80 give evidence of this potential. Even for the limited number of commodities shown, there are large volumes of products moving by surface that have values equal to or greater than $6 per kilogram. However, attention is called to the fact that each SITC commodity encompasses a range of product values. As an example, the product values for Parts, Office Machinery (SITC 71492) range in value from $2.95 to $94.17 per kilogram. There are other factors, such as packaging and deterioration, that are also determined by product characteristics and must be considered in evaluating the distribution cost.

Evaluation of the diversion potential of the Los Angeles to Japan network considered the commodities identified in Table 1-80 plus 33 additional commodities ranging from fresh or frozen beef (SITC 01110) to indoor game equipment (SITC 89424). For the year 1976, the selected commodities represented 48 percent of the total air shipments, 2 percent of the total surface shipments, and 2 percent of the total freight movement. It should be noted that the volumes of total freight and total sea freight moved include bulk cargoes (i.e., oil, grain, steel) not considered compatible with air shipment. Computation of the TDC was based upon the origin-destination mode variables presented in Table 6-6. These data, along with mode/product variables for the respective commodities, were acquired through research and field surveys conducted over an extended period under an on-going company-sponsored effort.

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TABLE 6-6

DISTRIBUTION COST VARIABLES - BASE CASE

Origin-Destination	Los Angeles - Japan	Air	Surface
Origin-Destination Mode Variables			
Distance	Km	4756.00	4840.00
Door-to-door Time	Days	2.00	20.00
Admin Labor Rate Warehousing	$/Kg	0.05	0.05
Warehouse Space Rate	$/Kg/Yr	0.10	0.10
Insurance Rate Inventory	Pct/Yr	0.02	0.02
Tax Rate Inventory	Pct/Yr	0.04	0.04
Capital Rate Inventory	Pct/Yr	0.20	0.20
Capital Rate In-Transit Inventory	Pct/Yr	0.20	0.20
Insurance Rate In-Transit Inventory	$/$	0.002	0.008
Pickup and Delivery Export	$/Kg	0.04	0.04
Pickup and Delivery Import	$/Kg	0.05	0.05
Inland Transport Export	$/Kg	0.00	0.06
Inland Transport Import	$/Kg	0.00	0.07
Port Handling Export	$/Kg	0.00	0.05
Port Handling Import	$/Kg	0.00	0.05
Documentation/Brokerage	$/Kg	0.10	0.15
Mode/Product Variables			
Packaging Cost	$/Kg	Vary with	Commodity
Physical Loss Rate in Inventory	%/Yr	" "	"
Economic Loss Rate in Inventory	%/Yr	" "	"
Inventory Turnover Rate	No./Yr	" "	"
In-Transit Inventory } Deterioration Rate	%/Day	" "	"
Custom's Duty Rate	% Value	" "	"
Retail Value Markup	%	" "	"

During 1976, the total movement of the selected commodities amounted to 44 075 tonnes of which 9.74 percent went by air. Analysis of the associated distribution costs indicates that a much larger volume of the select commodities could be moved by air at the same or less cost than by surface. The volume of freight falling in this category would be 30.8 percent of the total movement of 44 075 tonnes as compared to the 9.7 percent actually shipped by air. The contribution of specific commodities to this air potential is illustrated in Table 6-7. The commodities shown are those identified as being shipped by sea in Table 1-80.

The data of Table 6-7 indicate that the commodities chosen for Table 1-98 are fairly representative of surface freight that might be diverted to air. With the exception of Archery Equipment, etc. (SITC 89442), the quantity moving by air could vary from being doubled, in the case of plastic articles, to a 14-fold increase for liquid pumps. Note that machinery parts are very susceptible to diversion. As an example, 96 percent of aircraft parts and all the office machinery parts are identified as divertible in Table 6-7. As a result, the commodity value of the air potential threshold (APT) for these these two commodities is very near or at their minimum value points.

Sensitivity of distribution cost approach to input variables:—As previously noted, there are uncertainties associated with the input variables required in the TDC approach. When investigating past history (i.e., 1976) the evaluation of these variables involves their orientation to a specific network. In most such cases, the resource restrictions placed on the analysis effort necesitates a compromised solution based on the application of judgement to available data. On the other hand, when investigating a future market potential, it is necessary to estimate values for the input variables that are compatible with the total environment forecast to occur in the time period being considered. These estimated input variables must then be used in conjunction with the growth factors applied to account for projected commodity flows. Whether considering the past, present, or future market, the uncertainties associated with the definition of the input variables give rise to the question of their impact upon the resulting penetration potential. To answer this question, nine of the key variables of Table 6-6, plus the tariff, were perturbed about the base case as shown in Table 6-8.

TABLE 6-7

1976 AIRFREIGHT POTENTIAL - LOS ANGELES TO JAPAN

Commodity	Ave Density KG/M3	Commodity Movement Tonnes	Actual By Air Percent	Air Potential Percent	A.P.T. Product Value $/Kg
03130 Crustacea and Mollusks, Fresh, CH	480	4681	9.1	62	3.54
71492 Parts of Office Machinery NES	206	619	56.6	100	1.91
71842 Excavating, Leveling, Boring ET	619	3565	6.2	46	3.82
71921 Pumps for Liquids	356	633	5.1	70	3.39
72210 Electric Power Machinery	343	439	11.1	20	5.95
72492 Microphone Loudspeakers and Amplifiers	242	1725	9.3	14	5.25
73492 Aircraft Parts	170	855	54.1	96	4.77
89111 Gramophones Tape Records ET	198	481	4.3	93	2.57
89300 Articles of Artificial Plastic MA	103	1277	5.9	11	4.58
89442 Archery Equipment, Balls, Nets, Skis	134	1294	44.8	45	4.73

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TABLE 6-8

PERTURBATIONS OF DISTRIBUTION COST VARIABLES

Origin-Destination	Los Angeles - Japan	Air	Surface
Door-to-Door Time	Days		10
Tariff		10, 30, and 50% reduction in the difference between air and surface.	
Capital Rate {inventory, in-transit}	Pct/Yr	10, 25, 30, and 35	10, 25, 30, and 35
Warehouse Space Rate	$/Kg/Yr	0.05 and 0.15	0.05 and 0.15
Documentation/Brokerage	$/Kg	0.05, 0.15 and 0.20	0.05 and 0.15
Insurance Rate Inventory Tax Rate Inventory Physical Loss Rate Inventory Economic Loss Rate Inventory	Pct/Yr	+1 and +2	+1 and +2

Results of the air potential sensitivity analysis are shown in Figure 6-3. These data illustrate the changes in air potential that result from considered variations in the input variables to the TDC analysis. Five of the six input variables investigated have a relatively small effect upon the identified air potential. As would be suspected, the one remaining variable, tariff, is highly influential and should be considered in greater detail.

The effect of tariff (T) upon air potential is shown in Figure 6-3 as a function of reductions in the differential (ΔT) between the air (T_A) and sea (T_S) tariffs, $\Delta T = T_A - T_S$. The effect of such reductions is nonlinear. As an example, for the case considered, the greatest rate of increase in air

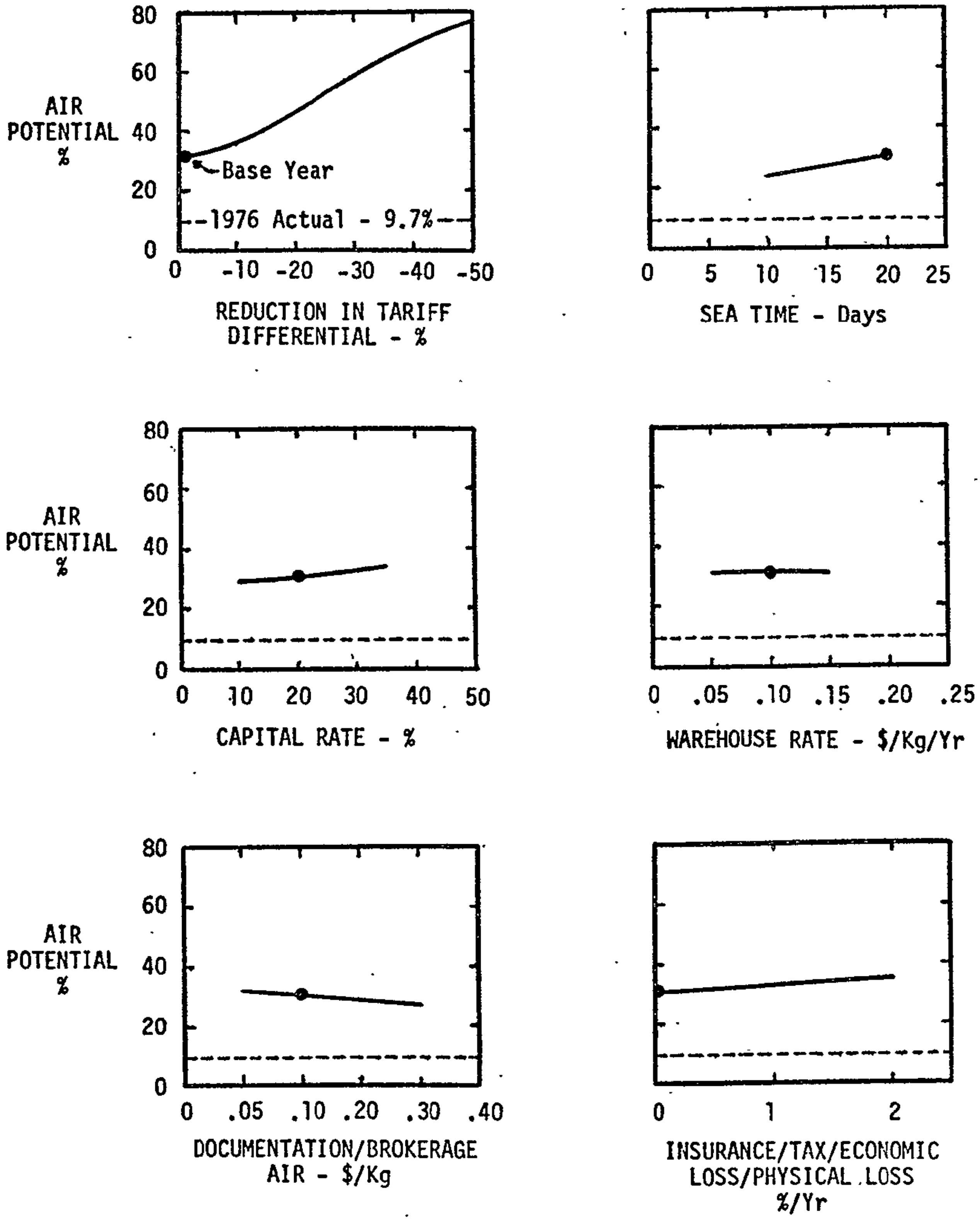

Figure 6-3. Air Potential Sensitivity - Los Angeles to Japan

potential occurs in the range of a 20- to 25-percent reduction in ΔT. The first 10-percent reduction provides a relatively small, 6 percent, increase in potential. Above a 30-percent reduction, any further reductions in ΔT results in ever decreasing incremental gains in potential. For this particular network, a 30-percent reduction in the tariff differential between air and sea could have been relatively productive in 1976, resulting in air potential of 64 percent compared to the base value of 31 percent.

The total distribution cost approach is viable providing the resulting air potential is viewed in proper perspective. The input variables must properly reflect and be compatible with the total market environment, whereas the results must be viewed in the framework of the shipper's relative view of the applicability of the respective transportation modes available. The results of this macroanalysis are merely an indicator of the amount of freight that could be diverted provided sufficient efforts are directed to developing a compatible air transport system backed up by a knowledgeable and energetic educational/sales effort.

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APPENDIX A

CARGO PROCESSING QUESTIONNAIRE

Douglas Aircraft Co./NASA Cargo Logistics Airlift Systems Study

____________________ Cargo Terminal At ____________________

ANNUAL TOTAL CARGO FLOW SUMMARY*

YEAR	FLOW DIRECTION	CARGO FLOW - BY AIRCRAFT TYPE					
		FREIGHTER		PASSENGER		TOTAL	
		Shipments	Weight-Lb	Shipments	Weight-Lb	Shipments	Weight-Lb
1970	Originating						
	Terminating						
	Transfer						
	TOTAL						
1973	Originating						
	Terminating						
	Transfer						
	TOTAL						
1976	Originating						
	Terminating						
	Transfer						
	TOTAL						

What significant events were associated with flow changes ? ____________________

____

What growth trends in cargo flow are considered probable in the next 10 years ?

____

____

*NOTE: If Annual Flow is not available in this format, flow for a typical month or week would be acceptable if so noted.

2. 1976 ANNUAL CARGO FLOW COMPONENTS*

CARGO DEFINITION	FLOW DIRECTION	CARGO FLOW - BY AIRCRAFT TYPE					
		FREIGHTER		PASSENGER		TOTAL	
		Shipments	Weight-Lb	Shipments	Weight-Lb	Shipments	Weight-Lb
INTERNATIONAL CARGO MOVEMENT	Originating						
	Terminating						
	Transfer						
	TOTAL						
SHIPPER LOADED CARGO IN ULD	Originating						
	Terminating						
	Transfer						
	TOTAL						

What trends do you see in shipper loaded cargo occurring over the next 10 years with respect to growth rate, container types and sizes, etc. ? ______________________

____

____

3. MONTHLY CARGO FLOW VARIATIONS

a. Maximum cargo flow of ____________ lb. and __________ shipments were handled during the month of ______________ 1976. Other high months were ____________

____

b. Minimum cargo flow of ____________ lb. and __________ shipments were handled during the month of ______________ 1976. Other low months were ____________

____

4. DAILY CARGO FLOW VARIATIONS

a. Maximum cargo flow of approximately __________ lb. and __________ shipments are usually processed on Mon. Tues. Wed. Thurs. Fri. Sat. Sun. of a normal week. (circle appropriate days)

b. Minimum cargo flow of approximately __________ lb. and __________ shipments are usually processed on Mon. Tues. Wed. Thurs. Fri. Sat. Sun. of a normal week (circle appropriate days)

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5. CARGO TERMINAL PROCESSING

a. What percentage of total cargo flow is composed of: Freight ________% Mail ______% Express (Priority) ______% Company Material ________%

b. What percentage (%) of total cargo flow is processed at the passenger terminal or elsewhere ________? Please explain: ______________________________

____

____

c. Average cargo storage time: Originating:__________hrs. Transfer:________hrs.
Terminating:__________hrs.

d. Peak Truck Dock Activity

FUNCTION	TIME SPAN	NO. OF TRUCKS SERVICED	AVERAGE LOAD PER TRUCK (LB)
Truck Unloading	_______ hrs. to _______ hrs.		
	_______ hrs. to _______ hrs.		
Truck Loading	_______ hrs. to _______ hrs.		
	_______ hrs. to _______ hrs.		

e. Peak Cargo Load Operations

FUNCTION	TIME SPAN	TYPICAL NO. OF LOADS SERVICED				
		LD-3	LD-5,7	Type A	M-1	20 Ft
Load Buildup	______hrs. to ______hrs.					
	______hrs. to ______hrs.					
Load Breakdown	______hrs. to ______hrs.					
	______hrs. to ______hrs.					

6. TERMINAL AND RAMP AREA

Terminal plot plan and floor plans are required for analysis of growth potential. Please include a copy with this form.

FUNCTIONAL AREA	AREA (SQ.FT.) OR DIMENSIONS	COMMENTS
Total Land Parcel		
Aircraft Apron Freighter		
Passenger (or gates used)		
Truck Dock & Parking		
Auto Parking		
Roadways		
Land for Future Development		
Total Terminal Floor Area		
- Bulk Cargo Storage - Inbound		
- Outbound		
- Cargo Module Storage - Inbound		
- Outbound		
- Cargo Processing - Inbound		
- Outbound		
- Load Breakdown/Buildup - Inbound		
- Outbound		
- Offices		
- Maintenance/Repair Shop		
- Equipment Storage		
- Personnel Area (rest, eat, dress)		

a. Maximum cargo capacity of the terminal is __________ lb. per month under existing conditions. The capacity is constrained as explained below:

Building: ______________________________

Cargo Storage: ______________________________

Truck Docks: ______________________________

Aircraft Ramp: ______________________________

Equipment: ______________________________

Manpower: ______________________________

Roadways: ______________________________

Airlift Capacity: ______________________________

Airlift Scheduling: ______________________________

Sales Effort: ______________________________

Others: ______________________________

b. Plans to increase cargo capacity are as follows: ______________________________

____

____

c. Cargo market development activities are placing emphasis on the following serv

____

____

. AIRCRAFT RAMP OPERATIONS

	INBOUND FREIGHTER OPERATIONS				
Major Flights - No.					
Days of Week					
Time Span - Hrs.to Hrs.					
Average Offload - Lb.					

7. AIRCRAFT RAMP OPERATIONS (Continued)

OUTBOUND FREIGHTER OPERATIONS					
Major Flights - No.					
Days of Week					
Time Span - Hrs. to Hrs					
Average Onload - Lb.					
Load Allocation - Lb.					

INBOUND PASSENGER AIRCRAFT CARGO OPERATIONS					
Major Flights - No.					
Days of Week					
Time Span - Hrs. to Hrs					
Average Offload - Lb.					

OUTBOUND PASSENGER AIRCRAFT CARGO OPERATIONS					
Major Flights - No.					
Days of Week					
Time Span - Hrs. to Hrs					
Average Onload - Lb.					
Load Allocation - Lb.					

NO. OF TOTAL AIRCRAFT OPERATIONS				
ACTIVITY	FREIGHTER		PASSENGER	
	NARROW-BODY	WIDE-BODY	NARROW-BODY	WIDE-BODY
Operations Per Week				
Operations Per Day				
Maximum				
Minimum				

What passenger and freighter aircraft requirements should be considered to meet future cargo growth potential?

Capacity/Density: ______________________________

Handling System: ______________________________

Speed: ______________________________

Range: ______________________________

Other: ______________________________

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8. CARGO MANPOWER REQUIREMENTS

FUNCTION	NO. OF EMPLOYEES*	TOTAL HOURS PER MONTH	HOURLY RATE** ($)
TERMINAL OPERATIONS			
Management & Administration			
Direct Supervision			
Warehousemen			
Traffic Agents			
Reservations			
Maintenance			
Custodial Service			
Other			
RAMP OPERATIONS FOR CARGO			
Management & Administration			
Direct Supervision			
Ramp Handling			
- Passenger Aircraft Cargo			
- Freighter Aircraft			
Maintenance			
Other			
SALES			
Management & Administration			
Salespersons			
Sales Support			
ACCOUNTING & FINANCIAL			
Management & Administration			
Office Personnel			
TOTAL			

* Note - If employees are shared with non-cargo functions, allocate headcount by approximate time devoted to cargo operations.

** Include cost of direct fringe benefits plus G&A.

9. CARGO PROCESSING COSTS

COST COMPONENTS	VALUE - $	COST PER YEAR* (1976)
FACILITIES*		
- Land		
- Land Improvements (Excluding Apron)		
- Freighter Apron		
- Passenger Aircraft Apron (Cargo Allocation)		
- Terminal Building		
EQUIPMENT*		
- Terminal Operations		
- Freighter Ramp Operations		
- Passenger Aircraft Ramp Operations (allocated to cargo)		
- Data Processing		
- Office Equipment		
- Maintenance Equipment		
PERSONNEL (Including Benefits)		
- Terminal Operations		
- Freighter Ramp Operations		
- Passenger Aircraft Ramp Operations Cargo		
- Sales		
- Accounting & Financial		
- Other		
MISCELLANEOUS		
- Insurance		
- Utilities		
- Supplies		
- Contract Services		
- Other		
TOTAL		

*Note - Based on investment or lease cost per year for facilities and equipment.

10. EQUIPMENT LIST

A list of equipment used for cargo terminal operations and ramp operations for cargo would be appreciated.

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