NASA Contractor Report 158916

(NASA-CR-158916) CARGO/LOGISTICS AIRLIFT SYSTEM STUDY (CLASS), VOLUME 2 (Lockheed-Georgia Co., Marietta.) 334 p HC A15/MF A01 CSCL 01C
N79-17823
Unclas
G3/03 14346

Cargo/Logistics Airlift System Study (CLASS)

Volume II

J. M. Norman, R. D. Henderson
F. C. Macey and R. P. Tuttle

Lockheed-Georgia Company
Marietta, Georgia

CONTRACT NAS1-14967
NOVEMBER 1978

NASA
National Aeronautics and
Space Administration
Langley Research Center
Hampton, Virginia 23665

TABLE OF CONTENTS

VOLUME I

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

III ADVANCED AIR CARGO SYSTEM DEMAND FORECAST

VOLUME II

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

LIST OF FIGURES

LIST OF FIGURES (CONT'D)

LIST OF FIGURES (CONT'D)

LIST OF FIGURES (CONT'D)

LIST OF FIGURES (CONT'D)

LIST OF FIGURES (CONT'D)

LIST OF FIGURES (CONT'D)

LIST OF FIGURES (CONT'D)

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES (CONT'D)

LIST OF TABLES

LIST OF TABLES (CONT'D)

IV - IMPORTANCE OF CONTAINERIZATION

Introduction

Although boxes, barrels, jars, and jugs were containers in ancient times, they hardly match the containers of the present. The cargo containers addressed here are relatively new, with the marine intermodal container birth coming in the mid-fifties and the air containers stemming from the sixties. The surface mode, marine, intermodal container concept caught hold, achieved standardization, and grew into a massive industry driving many of the bulk cargo ships from the seas. This large-capacity, door-to-door-capable, sea-truck-rail concept filled a timely need in service and in economics. O.I.M. Portion, President of Atlantic Container Lines observed (ref. 24), "...that from a commercial viewpoint the intermodal container has, through efficiencies of utilization, done more than any other transportation development to mitigate the steady advance of inflation..."

Air containerization had its beginning approximately a decade later than the surface modes. Although it grew rapidly with the introduction of narrow-body jets and main deck igloos, its growth scarcely compares with that of the marine ISO intermodal container. Containerization in the air carrier industry remains rather immature compared with the surface industry. Surface industry spokesmen have for some years expressed concern about the air carrier system approach as evidenced in this quote from Warren L. Serenbetz, CEO of Interpool, Ltd. (ref. 25),

> "How soon will air freight carriers eliminate the costly, time-consuming practice of loading and reloading individual cargoes or the popular non-intermodal air containers at the airports? If some of the unit-loading techniques now common to ocean carriers were extended to air freight, so that standard ISO containers were truly interchangeable between different modes, how much would that add to potential growth during the next decade? And who among us is to bet that it can't and won't happen in the next 10 years."

Richard Malkin in an Executive Editorial in Cargo Airlift (ref. 26) characterized the current situation:

> "The passenger airlines love belly cargo. It's the quickest road to Mecca. But, if they are going to place the weight of their attention on the belly dance, provocative as it may be, it will be quite another kind of air shipping industry that will emerge - one, I suspect, that will, until that elusive dream plane comes along, have to be content with less ambitious horizons."

Frost and Sullivan (ref. 27) referred to the following containerization Limitations nd Problems in their recent air cargo market study results:

1. Container use is not well suited to the emergency shipment nature of present-day air cargo, except where shipments between major-hub airports are concerned. Emergency shipments are usually small in weight and size, and any delay necessitated by consolidation of the packages with other destined for the same terminal reduces airfreight's speed advantage. Container shipments must be scheduled in advance, which does not aid in meeting emergency-shipment needs. Also, containers are of limited usefulness to shippers of small individual consignments moving to a multitude of different destinations.

2. Lower rate breaks are given for larger containers. Many shippers, however, find that rate breaks that would make possible a significant saving are too large for their needs. At times, the shipper must pay for unneeded volume.

3. Conversely, many high-volume shippers complain that the available containers are too small. The LD-1 and LD-3 containers designed for a wide body aircraft's lower deck have a 63-inch (1.6-meter) height limit, which is too small for a large number of products.

4. Another size-related problem is the allowance for oversize loads. For increased efficiency, pallets and containers have been designed to be closely assembled aboard all-cargo aircraft, with the result that little allowance exists for overhang. Often, a shipper is forced to pay for an entire extra pallet because his shipment was too large to fit in the space allotted for a single pallet.

5. Some of the early insulated and/or refrigerated containers had the same interior volume as non-insulated equivalents. This resulted in larger exterior dimensions because of the need for thick, insulated walls. Because aircraft interiors are not true cylinders, but are larger in certain areas than in others, these insulated containers could be used only in certain sections of aircraft fuselages.

6. A major problem with containers is the need for backhaul of empties. They must be moved to where they are needed, and it costs money to move them empty.

7. Ownership has also created problems. Forwarders for instance, have put a great deal of money into container acquisition, and are concerned about the amount of investment tied up and the return-on-investment when these containers are not in use.

8. Various interline agreements provide for an airline to use another's container (or pallet), or to ship it back to its destination. Up until 1972, this matter was taken care of through numerous separate agreements. However, an improvement was attained at that time in the form of an overall agreement which some, not all, IATA carriers endorsed. Thus even today, there is no uniform interchange agreement endorsed by all carriers.

9. Another strictly economic obstacle to the wider use of containers is the level of some container rates in relation to bulk rates for large shipments. The rather high pivotal bulk weights beyond which low rates exist are holding down the use of containers. Many times it is cheaper for a forwarder to present the airline with consolidated bulk load rather than for him to put it into a container, because the bulk rate may be cheaper than the container rate.

The same Frost and Sullivan report states affirmatively for containerization "... but it is on yet another issue that the future of the industry (air cargo) depends. That issue is containerization. Without further progress in the containerization program, rates must skyrocket and substantial bulk-shipper demand for air cargo will never develop." The authors further state: "What is necessary for a major increase in the use of containers is the ability to transfer them quickly and cheaply from truck to aircraft (and vice versa)." And further, "In spite of their attendant problems, the use of containers can drastically cut the airlines' operating expenses, and thus either lessen the rates charged the shipper, hold down the massive rate increases that will otherwise be necessary, or increase the airlines' revenues." The findings of Frost and Sullivan thus speak strongly for the further development of containerization with, as a minimum, an air-truck intermodal capability.

Support for an increasing amount of containerization, and an accompanying intermodal capability is not universal within the industry. Joseph Healy, Senior V.P. of Flying Tiger Lines in 1974 is quoted (ref. 28):

> "Containers aren't what they're cooked up to be in air transportation. This is where we part company with the industry...Air freight won't be moving in 40-foot (12.2-meter) highway trailers until the next century. It will be 10 years before there is sufficient demands to warrant the use of 8 x 8 x 20-foot (2.44 x 2.44 x 6.1-meter) containers."

Mr. Healy may be correct with respect to the highway trailers. However, in early 1977, Seaboard World Airways reported that "During a 64 day period (October 20, 1976 to December 23, 1976) Seaboard moved 963 20' (6.1-meter) containers between the U.S. and Europe. This averaged 15 container movements per day." In the past year, American Airlines and Container Transport International (CTI) have made an agreement wherein American will initially lease twenty-five 20-foot (6.1-meter) air containers which embody ISO compatible corner fittings. By March of this year this number has expanded to 100. Fred McCusker, American VP Freight Marketing, is reported (ref. 29) to have said that he could foresee 300 to 400 of the air containers in use by American in the near future.

The foregoing is recounted not to build a case against the FTL position, but to establish that wide-body main deck containerization is developing in a large container air-truck intermodal fashion. Actually, FTL showed profits in years that Seaboard World did not. To a great degree, however, this may be attributed to lack of large container rate incentives. Further on the subject from the initial decision of the CAB's Administrative Law Judge on the Domestic Air Freight Rate Investigation (Docket 22859/April 15, 1975):

> "Flying Tiger maintains that it is unjustly discriminatory to charge bulk and container shipments of equal weight different amounts... Flying Tiger's position does not recognize a fundamental difference between bulk and bypass-type container traffic. As the weight of the bulk freight shipment increases, the shipment ordinarily takes up more space and generates more facility expense. That is not the situation as regards a bypass container. Rather the container, because of its fixed size requires a given amount of space and incurs facility expense irrespective of the weight of its contents. Therefore, it is not unreasonable to treat the container differently from bulk freight. Since weight data are more readily available and convenient to use than volume data, it is appropriate to use weight to recover facilities expense attributable to bypass containers. The Bureau's methodology of applying the average weight of traffic by container type properly permits the recovery of costs while acknowledging the space-consuming characteristics of the containers."

In this introduction to containers, it is important to observe briefly the belly pits and the current status of belly (LD - Lower Deck) containers. In the narrow-body jet, containerization is generally limited to the main deck and the ATA type A igloo or equivalent pallet. There is an LD-W container in use by a few carriers, but the narrow-body bellies are essentially bulk-piece loaded. This is not the case with the wide-body bellies. Here, with the exception of the small, aft located/odd-shaped bulk compartment, the bellies are entirely containerized. The standards established to ULD's for the 747, DC-10, L-1011, and A-300, for the most part are fully interchangeable and, therefore, interlineable among carriers. (ULD stands for "unit load device" and applies to aircraft payload-carrying devices such as containers and to pallets with nets.)

The significance of the wide-body belly for cargo was evident from the planning stage. It could equate in volume and payload capability to nearly a whole narrow-body freighter. It was there to be filled on the many passenger aircraft, and when the energy "crunch" came in 1973 it became absolutely essential for carriers to try to fill it. Containerization was obviously mandatory to carry that volume, to meet short aircraft turn-around requirements, and to minimize ramp congestion. Passenger aircraft belly volume was offered at discount "daylight" rates, and provided additional revenue. Such occurrence caused reductions in all-cargo service and removal of many narrow-body freighters from service.

With the new wide-body bellies came a whole new family of "standard" containers, none of which is suitable for off-airport integrated ground transportation and the intermodal scheme. These and other containers will be discussed in detail later in this report.

Although it will be an essential part of the industry for many years, belly freight service is not the answer to achieving maturity in the air freight industry. John C. Cook of the Air Cargo Research Institute recently said (ref. 30):

> "Empty wide-body belly compartments are symptomatic of the ills facing the international air cargo industry. The big cargo breakthrough is still a long way away."

Alex Igylarto, Director of Cargo Sales, Northwest Orient Airlines, spoke to the general airline viewpoint recently (ref. 31):

> "To return to the idea whose time has come: Containerized air freight offers shippers greater speed, reduced inventory related costs, fewer handlings, less susceptibility to pilferage and damage. And it offers the carriers the opportunity of cutting their handling costs."

Yet, as here indicated, they are far from fully containerized:

> "At present about one-third of Northwest's cargo business is containerized. Specifically, on domestic shipments containers represent 37% of the revenue and 50% of the weight; internationally, containers account for 31.4% of the revenue and 36.8% of the weight."

This report will discusss physical and technical features and characteristics of both air and surface containers. Trends, ground handling, and intermodal aspects will be detailed. Container-oriented results of the case studies will provide both shipper and carrier responses and comment related to the systems of today and tomorrow. The advantages and disadvantages as seen through these users' eyes will be presented. Important cost considerations affecting containerization will be provided. Finally, the operational aspects of various air cargo systems, existing and projected, from emergency small package to large shipper-stuffed intermodal will be described and discussed.

Containerization

Technical Characteristics -

Aircraft ULD's: Growth of the air cargo industry has been greatly accelerated by the development of aircraft unit load devices (ULD's). Pallets and nets took their beginnings in the fifties and were followed by containers in the sixties. Aircraft ULD's are generally limited to operations from airport, but some are suitable to air-truck limited off-airport travel. Others provide lifting capability and intermodality with some limitations in stacking heights for marine mode operations. These aircraft ULD's come in many sizes, shapes, and types, in structural and non-structural configurations, and in ownership.

There are also "non-aircraft" ULD's which essentially are non-structural (non-certified boxes of various convenient sizes for the shippers. ULD's have varying tarrif rate classifications which generally, but not universally, provide more favorable rates for the larger capacity ULD's.

Table IV-1 shows all the current aircraft ULD's in general commercial use, their IATA (International Air Transport Association) classification rating, ID (identification) and specification, their USA domestic terminology (often ATA - Air Transport Association) and ID, along with cubic capacity, tare weight, and permissible gross weight information. Table IV-2 provides similar information for non-aircraft ULD's. It would appear that there is a ULD, 31 aircraft and 11 non-aircraft, for every occasion and use.

Aircraft ULD's consist of an assembly comprising one of the following:

1. Aircraft pallet and pallet net.
2. Aircraft pallet net over an igloo.
3. Aircraft container.

The purpose of the ULD is to enable individual pieces of cargo to be assembled into a standard sized unit to facilitate rapid loading/unloading onto an aircraft having compatible handling and restraint systems which interface directly with the unit device.

A non-aircraft ULD is one designed primarily to be loaded with cargo and subsequently loaded on/in an aircraft ULD, i.e., does not interface directly with aircraft handling/restraint system.

Aircraft ULD's are considered a part of the aircraft and as such must obtain the approval of one or more certification authorities. In the U.S. this is the FAA, and approval is granted either through a Supplemental Type Certificate (STC) or through inclusion in NAS 3610 (an AIAA - Aerospace Industries Association document) which is authorized under FAA TSO/C90. Specifications and standards for the majority of the aircraft ULD's have been prepared and issued by one or more of the following organizations: SAE - Society of Automotive Engineers, IATA, ISO - International Standards Organization, and ANSI - American National Standards Institute. For example, the spec/standard for Main Deck 8 x 8' (2.44 x 2.44-meter) Containers for High Capacity Aircraft is, in near identical form: SAE AS832, IATA 50/6, IS1496 Series I Part VII, ANSI MH5.2. Additionally, in NAS 3610, these containers in various lengths are coded 2F1C, 2G1C, 2H1C and 2J1C.

As air container tare weight must be subtracted from gross payload to obtain useful or revenue payload, it is important that the container be light in weight. As shape and shell thickness are controllable, an attempt is also made to provide a maximum usable volume within the container and within the aircraft. Strength for ground and flight maneuvers and for possible emergency landing dictates that the weight-saving consciousness should approximate that of aircraft design. These strength/weight/volume relationships dictate a requirement for thin-floor, thin-wall containers. As current air freighters

TABLE IV-1
MEMBER (AIR CARRIER) OWNED AIRCRAFT UNIT LOAD DEVICES

Description/Size	IATA CLASS Rating	IATA ID Code	IATA Spec	US Domestic Term.	NAS3610 ID	Representative Usable Volume Ft^3	Representative Usable Volume M^3	Tare Weight Lb	Tare Weight KG	Reference Max Gross Weight Lb	Reference Max Gross Weight KG	Remarks
8 x 8 x 20 Ft High Capacity A/C Main Deck Container	1	AS	50/6	M-2	2G1C	1160	32.3	2205	1000	25,000	11,340	Rect. Container
8 x 8 x 20 Ft High Capacity A/C Main Deck Pallet With Net	1	P7	50/9	M-2	2G1P	1160 1123	32.3 32(HD)	1000 1460	454 662	25,000	11,340	Rect. Pallet Load
8 x 8 x 10 Ft High Capacity A/C Pallet With Non-Struct Igloo	2	UR	50/3	(M-1)	2FIP	580	16.4	661	300	12,500	5670	Rect. Igloo/Net
8 x 8 x 10 Ft Main Deck Container for High Capacity A/C	2	AR	50/6	(M-1)	2FIC	580	16.4	1102	500	12,500	5670	Rect. Container
96 x 125 x 96 In Pallet With Net For High Capacity A/C	2	P6	50/1B	M-1	2MIP	625 619	17.7 17.5(HD)	287 573	130 260	15,000	6804	Rect Pallet Load
96 x 125 x 96 In Main Deck Container For High Capacity A/C	2	AQ	50/8	M-1	2MIC	620	17.6	1102	500	15,000	6804	Rect. Container
88 x 125 x 96 In Main Deck Pallet With Net For High Capacity A/C	2A	PI	50/1B	(M-1)	2AIP,3P 4P & 6P	558 530	15.8 15.0(HD)	267 381	121 173	15,000 13,300 12,500 10,000	6804 6033 5670 4536	Rect. Pallet Load
88 x 125 x 88 In Main Deck Non-Struct Igloo With Net	2AA	UAM	50/3	(M-1)	2AIP, 3P 4P & 6P	480	13.6	573	260	15,000 13,300 12,500 10,000	6804 6033 5670 4536	Rect. Igloo/Net
96 x 125 x 72 In Main Deck Pallet With Net	2B	P6	50/1B	(M-1)	2MIP	430	12.2	287	130	15,000	6804	Rect. Pallet Load
96 x 125 x 72 In Main Deck Non-Struct Igloo With Net	2B	UQ	50/3	(M-1)	2MIP	428	12.2	507	230	15,000	6804	Rect Igloo/Net
96 x 125 x 118 In Main Deck Pallet With Net For High Capacity A/C	2H	P6	50/1B	(M-1)	2MIP	717	20.3	287	130	15,000	6804	Non-Rect-10'High
96 x 125 x 118 Main Deck Shelf Pallet	2H		50/1B	(M-1)	2MICD	773	219	765	374	15,000	6804	Non-Rect. -10' High
88 x 125 x 86 In Pallet With Net	3	PI	50/1A, 1B,50/2	A	1AIP,3P 2AIP,3P	400	11.3	267	121	13,300 12,500 10,000	6033 5670 4536	Shaped Load
88 x 125 x 86 In Pallet With Non-Struct Igloo & Net	3	UA	50/3	A	1AIP,3P	400	11.3	485	220	13,300 12,500 10,000	6033 5670 4536	Shaped Load Igloo Net

TABLE IV-1, SHEET 2

Description/Size	IATA CLASS Rating	IATA ID Code	IATA Spec	US Domestic Term.	NAS3610 ID	Usable Ft^3	Representative Volume M^3	Tare Lb	Weight KG	Reference Max Gross Weight Lb	KG	Remarks
88 x 125 x 86 In Main Deck Container	3	AA	50/4	A	2A5C	400	11.3	728	330	13,300 12,500 10,000	6033 5670 4536	Struct Igloo
88 x 108 x 86 In Main Deck Pallet With Net	4	P2	50/1A, 1B 50/2	(A)	1B1P Etc 2B1P Etc	350	9.9	232	105	10,000 8,000	4536 3629	Shaped Load
88 x 108 x 86 In Main Deck Non-Struct Igloo & Net (80" H)	4	UD	50/3	(A)	1BIP 2BIP Etc	344	9.6	441	200	10,000 8,000	4536 3629	Shaped Load Igloo/Net
88 x 108 x 80 In Main Deck Non-Struct Igloo & Net (86" H)	4A	UD	50/3	(A)	1BIP, 2BIP Etc	353	9.9	463	210	10,000 8,000	4536 3629	Shaped Load Igloo Net
88 x 125 x 64 In Pallet With Net	5	PI	50/1A 50/1B	LD-7	2AIP,3P 4P,6P	360	10.2	267	121	10,000	4536	Shaped Load *
88 x 125 x 64 In Pallet With Non-Struct Igloo & Net	5	UA	50/3	LD-7	2AIP,3P 4P,6P	350	9.9	485	220	10,000	4536	Shaped Load Igloo/Net *
88 x 125 x 64 In Container	5	AA	50/4	LD-7	2A2C 2A5C	363	10.3	728	330	10,000	4536	Struct Container *
60.4 x 125 x 64 In Pallet With Net	6	P9	-	LD-5-11	2LIP	260	7.4	180	82	7,000	3175	Shaped Load *
60.4 x 125 x 64 In Container	6	AW	-	LD-5-11	2LIC	246	7.0	685	310	7,000	3175	Shaped Load * Struct Container
88 x 61.5 x 86 In Pallet With Net	7	P5	-	-		205	5.8	160	73	5,250 4,000 3,000	2,380 1,814 1,362	Shaped Load
88 x 61.5 x 86 In Half Pallet With Non-Struct Igloo	7	UP	-	B		217	6.1	294	134	5,250 4,000 3,000	2,380 1,814 1,362	Shaped Load Igloo/Net
60.4 x 61.5 x 64 In Certified Container For High Capacity A/C	8	AV	50/5	LD-1,-3	2KIC	152	4.3	300	136	3,500	1590	Shaped Load, Belly Half Container
60.4 x 61.5 x 64 In Non-Certified Container for High Capacity A/C	8	DV	50/7	LD-K				287	130	3,000	1360	Shaped Load, Belly Half Container

* Wide-Body Belly/Narrow-Body Main Deck

TABLE IV-1, SHEET 3

Description/Size	IATA CLASS Rating	ID Code	IATA Spec	US Domestic Term.	NAS3610 ID	Representative Usable Volume Ft^3	Representative Volume M^3	Representative Tare Lb	Representative Weight KG	Reference Max Gross Weight Lb	Reference Max Gross Weight KG	Remarks
60.4 x 61.5 x 64 In Rect. Non-Certified Container For High Capacity A/C	8C	DV	-		-	103	2.9	337	153	3000	1360	Rect Belly Half Container
60.4 x 81 x 64 In Non-A/C Half-Size Container on Pallet	8B	CX	-		-	151	4.3	396	180	4500	2041	Non-Aircraft ULD Series, Shaped
88 x 53 x 76 In Half Pallet With Net	9	P5	-		1E1P 2E2P	171	4.8	135	61	4,000 3000	1362	Shaped
88 x 53 x 76 In Half Pallet With Non-Struct Igloo	9	-	-		1E1P 2E2P	167	4.7	285	129	4,000 3,000 2,500	1,814 1,362 1,134	Shaped, Igloo/Net
Narrow-Body Belly Container (41 x 91 x 41)	-	-	-	LD-W	-	71	2.0	154	70	1700	770	Shaped

TARE WEIGHTS AND VOLUMES MAY VARY SOMEWHAT BETWEEN AIR CARRIERS

GENERAL SOURCE: IATA ULD MANUAL

TABLE IV-2
NON AIRCRAFT ULD'S

Description/Size	IATA CLASS Rating	IATA ID Code	IATA Spec	US Domestic Terminology	Representative				Permissible Max Gross Weight		Remarks
					Usable Ft^3	Volume M^3	Tare Lb	Wt KG	Lb	KG	
Half 125 In Pallet Size Container (83 x 58 x 76)	7	C03	70/1	B	172	4.9	300	136	6686	3029	Member Owned, Shaped
Half Size Interchange Container (33 x 58 x 75)	7	C04	70/1	B	157	4.4	277	126	6686	3029	Member Owned, Shaped
Mini Half Size Container (83 x 58 x 61)	8/9	C05	70/1	B	130	3.7	240	109	6686	3029	Member Owned, Shaped
Half 103 In Pallet Size Container (33 x 42 x 75)	8/9	C06	70/1	B	125	3.5	225	102	4841	2189	Member Owned, Shaped
Quarter Pallet Size Container (53 x 42 x 76)	-	-	70/1	B2	101	2.8	225	102	2500	1134	Member Owned, Shaped
Lower Deck Container Insert (54 x 54 x 56)	-	C07	70/1	LD-N	84	2.4	141	64	4050 2400	1820 1088	Member Owned, Rect.
Quarter Pallet Size Container (41 x 58 x 45)	- -	C08 C0J	70/1 70/1	D D	55 56	1.6 1.6	93 96	42 44	3303 3383	1498 1536	Member Owned, Rect. Non-Member Owned, R
ISO Base Unit - Container (40 x 48 x 40)	-	C09	70/1	-	38	1.1	44	20	2666	1207	Member Owned, Rect.
ISO Base Unit - Container (43 x 40 x 27)	-	C00	70/1	-	25	0.7	31	14	2666	1207	Member Owned, Rect.
Belly-Hold Container (42 x 29 x 25.5	-	C05	70/1	E	14	0.4	19	8.5	1691	768	Non-Member Owne , R

GENERAL SOURCE: IATA ULD MANUAL

have evolved from passenger aircraft, the quest for volume in containers in volume-limited aircraft have forced the industry into shaped containers - both in main deck and in belly application. A check of the currently used air containers as listed in Table IV-1 shows that today less than one-third of the ULD's have rectangular shapes. These requirements combine to make air containers appreciably more expensive than surface mode "marine intermodal" containers.

The non-aircraft family of ULD's (Table IV-2), some reusable and some disposable, present a somewhat counter-productive story from the tare wight penalty and containerization viewpoint. An example of the use of non-aircraft ULD's in an apparent extravagantly wasteful manner is that of placing LD-N rectangular, fork-liftable units inside LD-1 or -3's. The total tare is roughly increased by 50 percent while the usable volume is nearly cut to 50 percent. A 300-pound (136-kg), 150 cubic foot (4.3-cubic-meter) capacity container in essence becomes a 440-pound (200-kg) container with a 85-cubic-foot (2.4-cubic-meter) capacity. This scheme helps fill the bellies where rates are discounted in daylight service.

Logistically, the more expensive aluminum LD-3 container is kept on the airport while the less expensive (reusable but relatively short-lived) LD-N container is sent off airport. Only nominal terminal handling costs accrue as stuffing and stripping is shipper-provided. However, these factors are hardly illustrative of a maturing air freight system capable of penetrating substantial new markets. This by-product of passenger service does not necessarily pay its way as reported in the Domestic Air Freight Rate Investigation, but it is perpetuated by the Board with the logic that discount freight (daylight rate) could mean a savings for the passenger.

As indicated in Tables IV-1 and IV-2 and discussed earlier, standardization exists for air containers in many forms. The proliferation of standards necessary to fit the available market to the several narrow-body and wide-body aircraft main and lower decks is indicative of a make-shift approach to the handling and carriage of air cargo. In the ancilliary and subservient position relative to air carrier passengers, it has brought forth the current use of only one ULD which remotely resembles a ULD that the majority of CLASS case study shippers and carriers could accept. That container is a 8 x 8 x 20-foot (2.44 x 2.44 x 6.1-meter).

The M-2 container, as is the case with all aircraft ULD's, has a flat roller-conveyorable bottom. The container described in the standards is offered in two versions: (1) with a flush bottom only - meaning it must always be handled on a conveyorable surface (including rollerized flat bed trailers), and (2) with a flat bottom and ISO corner fittings. This latter Type B version of the container thus may go on/off the aircraft on rollers and may also be lifted and set down outside the aircraft. The Type B container can be placed and carried upon ISO chassis for ground transportation. It may further be stacked two-high (top positions) for ocean carriage on container ships or in dockside marshalling/storage yards.

The ULD standards for the above 20-foot (6.1-meter) air containers cover containers of 30 and 40-foot (9.15 and 12.2-meter) lengths. Such are not listed in Table IV-1 as they are not in service at this time. It is further unlikely that they will enter service in the near future, as compatibility with the current civil freighters which could accept them dictates that they have a low stiffness value so that they will readily deflect under load to conform to the deflections of the aircraft floor under varying loads. Pallets of these lengths are more likely to be used as they are inherently less stiff than containers.

Aircraft ULD's for the U.S. military have been standardized around the nine-foot 463L System gauge. The primary pallet is the "full" size (88 x 108-inch) (2.24 x 2.74-meter) unit. Half pallets of 88 x 54-inch (2.24 x 1.37-meter) dimensions are used in the USAF-contracted (civil supplemental carrier) LogAir and USN Quick Trans air cargo services. Longer loads are either carried as spanning loads on multiple adjacent pallets or on modular 9-foot (2.74 meter) wide airdrop platforms (which vary from 8 to 28-foot (2.44 to 8.53-meter) increments). A few structural 88 x 108-inch (2.24 x 2.74 meter) 463L System containers were procured some years ago; they have received limited acceptance and use. These military ULD's are not included among the commercial listings of Table IV-1.

With respect to ULD classification ratings for tariff purposes and physical characteristics for interline compatibility, both IATA and ATA-Air Transport Association provide standards. The IATA listing is adequately included in Table IV-1. The domestic ATA standards are considered to be of insufficient detail to be universally workable. Most domestic air carriers are also IATA members and thus are fully familiar with IATA standards. The IATA covered units are the Type A, B, B-2, FT-B, D, Quarter D, E, LD-1, LD-3, LD-5, LD-7, LD-11, LD-W and LD-N. Additionally, add the 8 x 8-foot (2.44 x 2.44-meter) High Capacity Aircraft Main Deck Containers loosely Tabbed M-1 for a nominal 10-foot (3.05-meter) length and M-2 for the 20-foot (6.1-meter) length.

Surface Mode Intermodal Containers: The ISO marine container is a phenomenal economic success if its growth in use is a fair indicator. Malcolm McLean started a transportation revolution when, in 1956, he demonstrated a dockside system in which truck load lots of cargo could be loaded/unloaded on/from ships without the time-consuming and expensive break bulk operations. The use of large demountable containers, whose size was ideally suited to ground transportation, fostered the rapid growth of this new sea-land industry and its accompanying technology.

Container physical characteristics and capacities are provided in Table IV-3. Standards governing most of these container sizes have been prepared by both ANSI and ISO. Standards exist for several sizes, 10 and 30-foot (3.05 and 9.15-meter), which have not caught on. Several other sizes are in very limited use in captive systems, i.e. 24 and 27-foot (7.3 and 8.2-meter) Matson Line. The Sea-Land 35 foot (10.7-meter) length is captive to S-L and Pureto Rico Marine Management, Inc. However, it represents over 10 percent of

TABLE IV-3

ISO SURFACE MODE/MARINE - INTERMODAL CONTAINERS

Description/Size	Representative Range of Tare Weight Lb	KG	Max Gross Weight Lb	KG	Representative Cubic Capacity Ft^3	M^3	Percent of Domestic Population	ANSI STD	ISO STD
8 X 8 X 40'	5200 - 8400	2630 - 3830	67,200	30,480	2250	64	32.0	X	X
8 X 8.5 X 40'	5900 - 8500	2680 - 3860	67,200	30,480	2400	68		X	X
8 X 9 X 40'	6300 - 8500	2860 - 3860	67,200	30,480	2550	72			
8 X 9.5 X 40'	6500 - 8500	2950 - 3860	67,200	30,480	2700	76			
8 X 8.5 X 35'	5500	2500	61,600	27,940	2100	60	12.0	X	
8 X 8 X 30'			(56,000)	(25,400)			0.18	X	X
8 X 8-1/2 X 30'			(56,000)	(25,400)					
8 X 9-1/2 X 27'			-	-			0.70		
8 X 8-1/2 X 24'	4100 - 4900	1860 - 2200	50,000	22,680	1400	40	2.3	X	
8 X 9-1/2 X 24'	5250	2380	50,000	22,680	1520	43			
8 X 8 X 20'	3200 - 5000	1450 - 2270	44,800	20,320	1100	31	52.9	X	X
8 X 8-1/2 X 20'	3200 - 5000	1450 - 2270	44,800	20,320	1200	34			
8 X 8 X 10'			(22,400)	(10,160)			0	X	X

WEIGHTS AND VOLUME BASED ON DRY VAN CONTAINER CONFIGURATIONS

GENERAL SOURCE: INVENTORY OF AMERICAN INTERMODAL EQUIPMENT 1976 U.S. DOC MARAD
PLUS ANSI & ISO STANDARDS

the domestically owned inventory. The 20 and 40-foot (6.1 and 12.2 meter) lengths by far dominate the domestic inventory, and encompass even a large segment of the total internationally. All containers are readily identified by the presence of ISO corner fittings at each of the eight corner locations, and when transported on chassis overland, by a complete lack of lights above the chassis level at night.

Tare weight of these containers is higher than for air containers. Tare weight ranges are significant as materials of container construction are less standrd than for the air containers. The lightest-weight containers are of aluminum construction with heavier containers of RFP-Fiberglas Reinforced Plywood and of steel in common use. Ten years ago one could buy containers of this type in production quantities for fifty cents per pound ($1.11 per kg). Although that pricing is of the past these containers, built primarily by truck trailer manufacturers, remain very competitively priced.

DoD Container Specifications and Requirements: The U.S. Army owns some 6700 MILVAN containers. These containers are basically ANSI/ISO intermodal 20-foot (6.1-meter) length containers specified to be of steel construction. Some have a considerable non-ISO internal tie-down capability. Tare weight ranges from about 4500 to 5400 pounds (2040 to 2450-kg), which is very heavy. Subsequent DOD policy (ref. 33) called for the employment of the container resources of the commercial transportation industry to the extent that such support is responsive to military requirements. The policy instruction further specified:

> "Containerization for the transport of military cargo will be utilized to the greatest practicable degree, subject to ... such things as cost effectiveness, etc."
>
> Another DOD directive (ref. 34) states relative to transportability including airways that "...design will specifically consider the impact of international standardization of intermodal containerization in standardizing and facilitating world-wide distribution."

In recent years there has been occasional Army need to have a 20-foot (6.1-meter) intermodal container moved by air. The Air Force has accomplished this by placing the non-flush bottom container on a 9-foot (2.74-meter) wide aerial delivery platform and then loading the combined load in a conventional roller-conveyor fashion. The load is shored on the platform to ensure an equitable load distribution, it is secured to the platform with tie-downs, and the platform load is secured to the aircraft by the restraint rail locks after loading on roller-conveyors.

The 20-foot (6.1-meter) container: Several civil carriers have also carried 20-foot (6.1-meter) marine intermodal containers in their 747 freighters. A similar slave pallet/platform is utilized with its gauge set at 8-foot (2.44-meter). Because the thickness of the slave pallet adds to the overall height, this unit is normally restricted to side door loading where sufficient clearance height is available. Marine intermodal containers are currently considered satisfactory only for non-routine/emergency use by most carriers. However, Seaboard World has made considerable use of the ISO marine containers as noted in the following quotes from Air Transport World (ref. 35):

> "In 1977 Seaboard's 747's carried more than 6000 20-foot (6.1-meter) equivalent sea containers... in addition to its own aluminum (air) containers."
>
> "Seaboard leases some 200 of the sea containers in order to have a sufficient stock of 20-foot (6.1-meter) boxes for its shippers. However, it is studying the purchase of 50 to 100 aluminum containers in addition to the 52 now owned. The purchase would be more to reduce leasing costs than to cut tare weight." Seaboard's aircraft and routes are such that tare weight is generally not critical as the aircraft cube out prior to payloading out. Seaboard aggressively seeks the large shipments. "About half of Seaboard's current tonnage consists of shipments weighing more than 20,000-pound (9090-kg) although such shipments account for only 3% of the waybills."

For a look at alternative aircraft interface and loading/unloading means not requiring slave pallets, it is suggested the reader review the Project INTACT program results (ref. 36). In that joint government/industry intermodal air cargo test program, 8 x 8-1/2 x 40-foot (2.44 x 2.59 x 12.2-meter) marine intermodal containers were loaded, flown and unloaded from C-5 aircraft utilizing new and novel shuttle loading concepts. These rollerless (non-conveyor) schemes accomplished the handling tasks via both wheeled and air-bearing equipment which placed the non-flush bottom containers on blocks on the cargo floor of the aircraft, depressed below the container bottom, and withdrew to the interface dock to load the next container.

Other ULD's: Over-the-road trailers form by far the largest number of dry van containers. These non-demountable containers have been adaptable to intermodal carriage via the "piggyback" railroad system and he "ro-ro" (roll-on, roll-off) shipboard concept. The trailer units suitable for these intermodal uses are built to special criteria establishing structural and/or dynamic compatibility for the various modes.

Increasing volume demands for increased productivity per tractor and tractor driver has forced, in line-haul trucker applications, the use of longer and higher trailers and the use of more and longer double- and triple-bottom rigs. One major motor carrier commented in the case study responses that all their line-haul equipment was either 27 or 45 feet (8.2 or 13.7-meters) in length and 9 or 9-1/2 feet (2.74 or 2.9-meters) high. This line-haul quest for volume is mentioned here to show that more volume is a generally universal requirement among all modes and not singular to any one mode such as air.

Structural Considerations: In November of 1975 J. Bruce Gebhardt of United Airlines said on the subject of intermodalism and air (ref. 37):

> "Have you ever been in a sea-container yard? If you have you know that those delicate little things tnat we call containers couldn't last a minute."

Thus an air cargo industry executive gave his assessment of the relative hardiness of air containes in the surface mode intermodal container environment.

In a way, the opposite is true, at least on paper. Design load factors are provided in air container specs and standards for both operational (limit) and ultimate strength requirements. The ANSI/ISO surface mode criteria specify only an operational load level. Operational/limit load criteria dictate that the container may deflect under load, but that upon removal of the load there shall be no permanent set or deformation. Ultimate design load criteria for containers accept permanent deformation but do not allow for rupture or discharge of contents.

With respect to container strength requirements in three directions, note in the following table that air requirements are indeed higher than those governing surface containers:

OPERATIONAL/LIMIT LOAD REQUIREMENTS

	AIR MODE	SURFACE MODES
FORE/AFT	1.0	0.4
SIDE	1.0	0.6
VERTICAL UP	1.0	0.0

The design max gross weight for the two types of containers vary considerably, as shown:

MAX GROSS WEIGHT CAPABILITY - LB (KG)

	10' L (3.1m)	20' L (6.1m)	30' L (9.1m)	40' L (12.2m)
AIR	12,500(5,670)	25,000(11,340)	35,000(15,876)	45,000(20,412)
SURFACE	22,400(10,160)	44,800(20,320)	56,000(25,400)	67,200(30,480)

Therefore, the real relative capabilities based on requirements are:

OPERATIONAL/LIMIT LOAD CAPABILITIES - LB (KG)

	AIR MODE		SURFACE MODE	
	20' L (6.1m)	40' L (12.2m)	20' L (6.1m)	40' L (12.2m)
FORE-AFT	25,000(11,340)	45,000(20,412)	16,000+(7,260)	24,000(10,880)
SIDE	25,000(11,340)	45,000(20,412)	24,000+(10,880)	36,000(16,330)
VERT UP	25,000(11,340)	45,000(20,412)	0	0

So those delicate little things would not seem so delicate if only these requirements were used in the comparison. A number of factors point to the actual strength of the surface mode containers being greater than indicated in the foregoing. First, the surface containers are not tested beyond the operational load level; a test at the ultimate load level (or to destruction) would determine the actual strength of the container. Another factor pointing to added strength stems from requirements for lifting, stacking, and ground operations which are peculiar to the ground requirements. Last, a review of several representative container manufacturer drawings showed generously-large marings of safety, much larger and less weight conscious than that necessary within the air industry.

The delicate little containers Mr. Gebhardt referred to would, in fact, be just that for the most part if they were to be ground-handled and transported in the manner and for the distances normal to the sea-containers. The line haul for the air container is usually an extremely soft ride, and since most air containers stay on or close to the airport, they experience little of the bouncy surface transit of the others. This, of course, is changing as requirements for M-2 type B containers, for instance, have ground handling design requirements similar to ISO marine containers.

Internal Tie-down: Internal tie-down is a firm requirement in the air container standards because aircraft may, although rarely, develop vertical accelerations sufficient to lift cargo up and slam it down. In normal packaged freight where a sufficient percentage of the internal volume of a container is filled, this condition may be ignored. If the volume is insufficient - too much air above the cargo - then either dunnage (light weight filler material) or internal tie-down is required. For similar reasons with very dense items such as engines, generators or machinery may also be required to restrict fore-aft-side movement by tie-down. In air containers provisions for internal tie-down are a spec or standard requirement.

For surface mode ISO marine containers there are no specified requirements for internal tie-down. However, as with dry van trailers, there are containers procured with a variety of internal tie-down provisions, some suitable for the erection of internal bulkheads. Here the internal tie-down, where used, is applied to restrain cargo against fore-aft-side movement only. The most common manner of achieving this is with wooden cleats nailed to the wooden floor.

Chassis Interfaces: The new M-2 container, like the ISO marine container is capable of being transported over-the-road on the skeletal chassis of the surface intermodal systems. These chassis are available in large numbers world-wide. However, in the field of standardization, the chassis has been somewhat of a stepchild. There have been occasional problems in fitting ISO marine containers to the chassis. The air container, although designed with compensatory corner fitting base thickness to account for the flush (or even recessed) corner fitting, also has fallen victim to the misfit problem. Current reports from the air industry fault the chassis, primarily in the areas of "raised bolsters" and "bowed twin I-beams." No effort is made in this report to further identify this problem.

One solution to the problem is for the carrier and/or lessor to provide an inventory of captive compatible chassis. The ANSI committee on freight containers is currently receiving a draft of a newly proposed standard (MH5.6) for chassis.

Depressurizations: There is an air requirement for vent/blowout panels to allow the container and the aircraft cargo compartment internal pressures to equalize quickly. This must be achieved in time to prevent the container or any of its cargo from becoming missile if there were a rapid depressurization of the cabin. The ISO marine container does not have this design requirement. However, a military test conducted upon an empty MILVAN container showed that, in this worst case (empty volume), the container doors, door seals, and some structural seams deformed or separated sufficiently that the interior of the container was exposed to only a fraction of the pressure differential load which might have been applied. Nothing became missile.

Technical Discussion of Future: Air containerization is on the threshold of intermodality for the few carriers equipped to carry the 8 x 8-foot (2.44 x 2.44-meter) M-2 box. Of these few carriers, only one is operating on U.S. domestic routes, yet this carrier (American Airlines) has moved out the most progressively of all with respect to equipment, as evidenced by its use of straddle cranes and leased containers.

The strength differences and tare weight differences between air and surface containers deserve further comment. The time has come when representative ISO marine containers should be tested to air mode ultimate load levels to provide information which could possibly upgrade their capabilities for expanded air use. The tare weights for the aluminum surface mode containers, made with alloys with allowables 50% of these used in aircraft, could be substantially reduced as evidenced by the M-2 continers, and the acceptance of non-wood plank floor and lesser stacking requirements could further reduce tares for non-flush-bottom intermodal containers.

Why non-flush-bottom containers? One reason is that the U.S. DOD is directing their use. Further, if there becomes a need to move 40-foot L (12.2-meter) air containers, it is unlikely that the present air container criteria for 30-foot and 40-foot (9.15 and 12.2-meter) containers, which are peculiarly tailored to 747 fuselage floor stiffness, will be acceptable. At the same time, the Type B M-2 container has its lower corner fittings, because of its flush bottom, either flush or recessed as opposed to protruding in the case of the ISO marine container. This necessity for use on roller-conveyors also necessitates the use of functional twist-lock spacers when the container is stacked, and has contributed to some interface problems with some existing container chassis.

Our contemporary air cargo systems, operating on conveyors as they do, represent a large investment, and for the sake of interchange and interface with existing equipment, all new equipment must, be aircraft, ramp, and terminal compatible with existing equipment. Therefore, the issue is not a question of whether a "rollerless" loading system is superior for large containers over the present roller conveyors; it is whether an incompatibility with existing air systems can be tolerated economically in the near term. So the question of change is more difficult for those reasons of large investments in current systems. This situation requires both civil and military operators to carry the ISO marine containers on slave pallets or platforms whenever there is a demand.

In summary, the present air system is cautiously moving toward the air-truck intermodality available with the M-2 containers. The slave pallet will continue to be required as long as there is any. Very few ULD's longer than 20 feet (6.1-meters) will be loaded, and when loaded will generally be pallets. The development of light-weight, non-flush bottom (air-included) intermodal containers and rollerless handling systems is unlikely in the near term but should remain as a viable option for the Advanced Intermodal Air Cargo System. In the interim, additional new "standards" peculiar to the available flight equipment, such as the 96 x 196-inch (2.44 x 5-meter) pallet loaded through the side-door 747, may continue to be issued.

Container Growth Trends -

Air Containers: This discussion will be limited to the 8-foot (2.44-meter) gauge containes. The new family of 8 x 8-foot (2.44 x 2.44-meter) cross-section containers is becoming somewhat a common ULD among the wide-body freighter-equipped carriers. The 20-foot (6.1-meter) M-2 container normally moves in a mix with lesser length containers and pallets. The most universal and popular 8 x 8-foot (2.44 x 2.44-meter) container is the end restrained 96 x 125 x 96-inch (2.44 x 3.175 x 2.44-meter) M-1 container. Frequently this ULD is not really a container but an igloo and net over a pallet. It is noteworthy that the non-modular 125-inch (3.175-meter) ULD is, by far, more popular than the modular 117.75-inch (3-meter) ULD; both are commonly called "10-foot" (3.05-meter) containers.

Flying Tiger, followed by others, brought forth an increase in height from 96 to 118 inches (2.44 to 3-meters) in a modification of the M-1 unit. This taller ULD, called a "shelf-pallet," is currently limited for use to carriers with the increased vertical clearance 747 side-door installation, and to those aircraft cargo floor positions aft of the elevated flight station/upper deck. Shelf-pallets are shaped in that one upper edge is scarfed to clear the structure of the available cargo envelope. This raised-height pallet fulfills a desire for increased height and volume.

A failure to date to introduce the 30- and 40-foot length containers at all may be attributed to: (1) increased difficulty in handling loads of these lengths, (2) special ULD structural stiffness requirements for compatibility with 747 aircraft structure, and (3) inability to generate routine loads of this size. It is fair to state that present air freight methods have not created a significant demand for containers of lengths in excess of 20-feet (6.1-meters), although the 40-foot (12.2-meter) length containers offer advantages in over-the-road transport and at shipper docks.

The M-2 container inventory at the end of 1977 is not large, but it is growing. According to Phillip L. Peoples, Director of Air Freight Systems at

Boeing (ref. 38), "...there are now (Jan. 1978) 380 8 x 8 x 20-foot (2.44 x 2.44 x 6.1-meter) containers used by air freight companies."

Two trends are of significance relative to these containers and the air cargo industry: (1) a strong movement to the Type B containers with corner fittings, and (2), perhaps forecast with insufficient evidence, an early movement to container leasing. The first trend is important in that, by integrating a "lift/set down" capability, the industry is pointing toward increased intermodality and the use of already developed handling and transport equipment suitable for ground use. The introduction of container leasing will facilitate the growth of this type of air containerization as it reduces capital costs and may reduce logistic control problems for the air carriers. CTI, Container Transport International, is the initial provider of these containers to the industry. American Airlines is the initial user.

Surface Mode Containers: ISO containers (Table IV-3) easily exceed one-half million units currently. Warren Serrenbetz (ref. 25) predicted in 1976 that new production of over two million units would be required to account for both the growth and replacement requirements in the 10 years to 1986. U.S. carrier and leasing company totals, as reported by the U.S. MARAD (ref. 39) numbered 503,241 at the end of 1976. The number of TEU's(6.1-meter/20-foot equivalents) was 713,060. James P. Thrasher of Interway (ref. 40 says the total world leased population is about 680,000 TEU's as of January 1978.

The growth of the U.S. container fleet has slackened, especially in carrier-owned category. In 1973, the growth over the previous year was 17 percent, whereas in 1976 it was 2 percent. For leased ownership, the figures were 27 percent for 1973 and 10 percent for 1976. The ratio of lessor-owned to carrier-owned was 60:40 at the end of 1976 in these domestic comparisons.

Five-year growth trend curves for container length and for height of both 40- and 20-foot (11.2 and 6.1-meter) containers are repeated from a MARAD publication (ref. 16) in Figures IV-1, IV-2 and IV-3. The 20-foot (6.1-meter) containers outnumbered 40-foot (12.2 meter) containers 5 to 3, and as shown in Figures IV-1, are increasing that ratio a little each year since 1973. Heights of 40-foot (12.2-meter) dry van containers are reasonably stabilized with the 8.5 foot (2.6 meter) freight representing 87 percent of the total, and Figure IV-2 shows 9-foot (2.74-meter) and 9.5-foot (2.9-meter) containers outnumbering 8-foot (2.44-meter) heights by 3 to 1. Only in Figure IV-3 providing height data for 20-foot (6.1-meter) long containers is there a pronounced current change in progress. Essentially all new 20-foot (6.1-meter) long containers is there a pronounced current change in progress. Essentially all new 20-foot (6.1-meter) dry van containers are 8.5 feet (2.6-meters) high. In 1972 the 8-foot (2.44-meter) to 8.5-foot (2.6-meter) height ratio was 93:7. At the end of 1976 it was 53:47. The trend to a greater height than 8-foot (2.44-meter) is, therefore, overwhelming in the 20-foot (6.1-meter) length. In the 40-foot (12.2-meter) length, (97 percent of the total domestic inventory is of a height greater than 8-feet (2.44-meters).

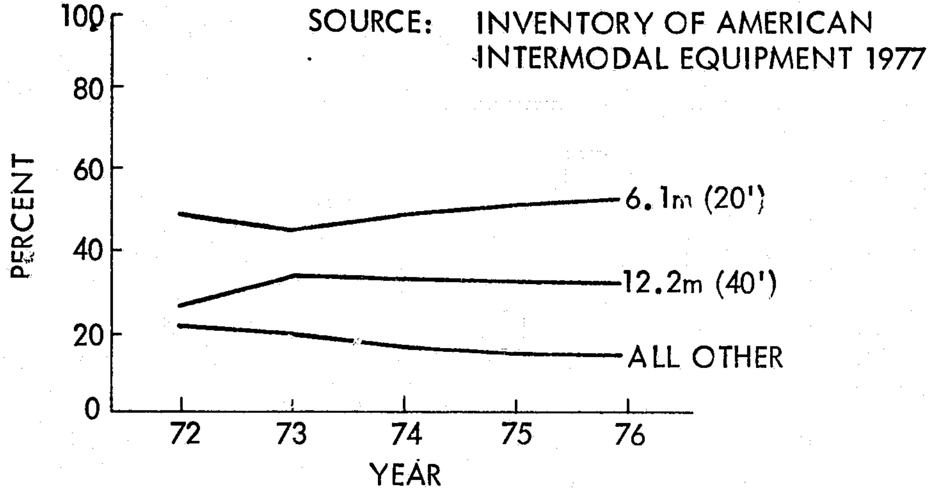


FIGURE IV-1. TRENDS IN CONTAINER LENGTHS

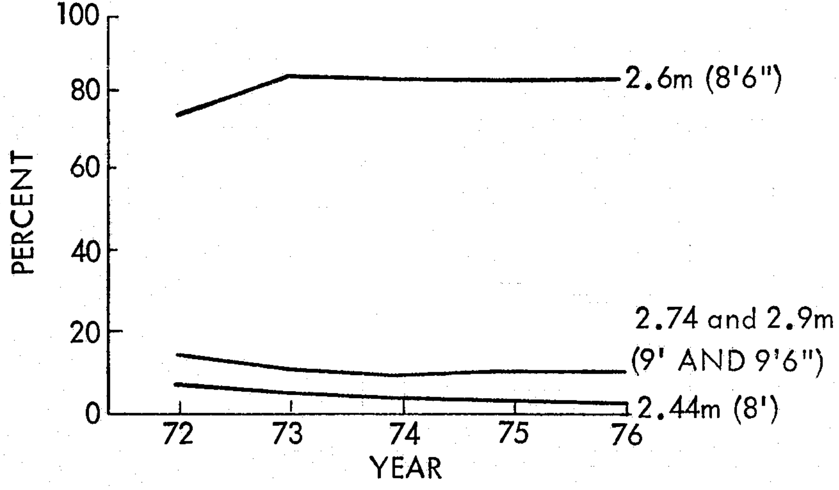


FIGURE IV-2. TRENDS IN 40' DRY VAN CONTAINER HEIGHTS

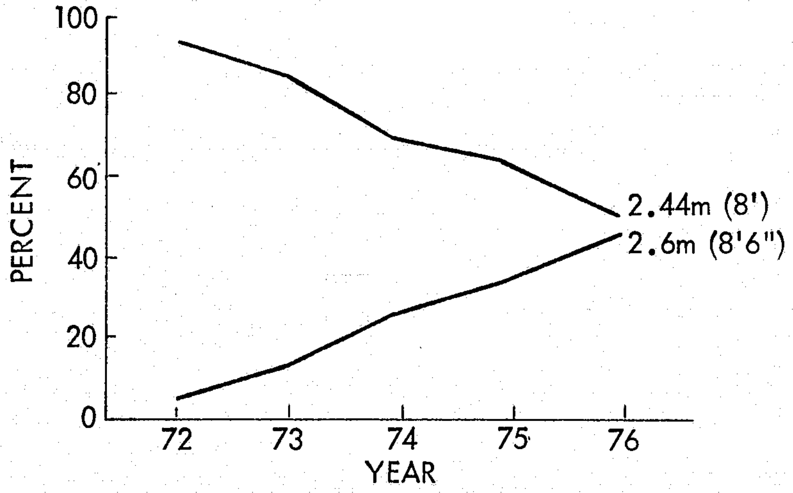


FIGURE IV-3. TRENDS IN 20' DRY VAN CONTAINER HEIGHTS

Of interest in the inventory statistics is the inclination of the carrier to procure containers of aluminum construction. The lessor, who puts his container out to perhaps greater risk, buys a preponderance of the less expensive, heavier, and perhaps, hardier steel containers.

In a nutshell, size changes in surface mode containers are directed toward maximizing volume efficiency. This need for involved volume was generally substantiated in the result of the use study reports from both shippers and carriers concerning potential container improvements.

Intermodality - "What is intermodalism? Intermodalism consists of two factors: (1) containerization of the freight by the shipper in a special receptacle designed to interface with the carrier(s) vehicle(s), and (2) unit transfer of the containerized freight between two or more transportation modes."

The above quote is from an address by John H. Mahoney of Seaboard World Airlines (ref. 41) in 1974 when Seaboard was kicking-off their 8 x 8 x 20-foot (2.44 x 2.44 x 6.1-meter) "intermodal" operation. The quoted definition of intermodalism would be enhanced if it is understood that the "special receptacle" must be a standardized multi-mode ULD of suitable proportions to carry cargo in an economical manner and that the handling of the "unit transfer" and the transport between all modes be efficiently conducted.

From the long list of ULD's in Table IV-1, only one container offers promise of achieving strong intermodal acceptance and use. That container is the 8 x 8 x 20-foot (2.44 x 2.44 x 6.1-meter) M-2 container. Those procured without corner fittings are limited to a life on roller conveyors, and truck movement calls for a rollerized flatbed. Those M-2 containers procured with corner fittings are intermodal in the sense that they can be lifted and set down with existing intermodal container lift equipment, can be transported on the highway on ISO chasses, can be stacked two high for both ocean transport and storage (top two locations only), and can be transported COFC (container on a flatcar).

Operational Container Test Program: During 1975-76, Air Cargo, Inc. in conjunction with American Airlines, Seaboard World Airlines, Air France and Northwest Airlines conductd an operational container test program using sixteen M-2 Type containers. The containers were manufactured by Bruggermann & Brand, Fruehauf, and Messerschmitt-Boelkow-Blohm. The technical/functional phase of the test evaluation program was complete by the Fall of 1976. The evaluation also included a structural test phase on a representative container of each type from each manufacturer, four containers in all. From the technical phase, problems were found in floor construction and in inadequate internal tiedown. Problems also existed in truck dock interface with dock door-lower corner fitting incompatibility. Operationally, it was apparent there would be regulatory/legal pooling arangement problems.

Subsequently, Air Cargo, Inc. (ACI) selected the MBB container and proposed a pooling arrangement to the airlines which would have been coordinated and serviced by ACI. This proposal was not accepted by the airlines and was abandoned.

More recently, in a limited follow-up, CTI, Container Transport International (the world's largest marine container lessor), purchased a number of containers M-2, Type B, with approximately a 2220-pound (960 kg) tare weight and 1165-cubic foot (33-cubic meter) volume from Transequip/Bruggermann & Brand and leased 25 to American Airlines. American's program extends to all points served by the side-door 747 Fleet: JFK, ORD, DFW, SFO and LAX. Even more recently, the quantity of 25 containers has grown to 100.

Ground Handling: Intermodal concept can exhibit important benefits in ground handling operation. Divided into four major subfunctions, the equipment and procedures for accomplishing each function vary widely as described below:

- Stuffing/Stripping - An intermodal size container such as the 20-foot (6.1-meter) M-2 can be handled at the producer/shipper/user/consignee dock in the same manner as a 40-foot (12.2-meter) trailer. On its ISO chassis the 20-foot (6.1-meter) container can be positioned at the shippers' loading dock and worked by conveyor belt, gravity conveyer, fork truck, etc. The consolidation of this container by an air freight forwarder or carrier poses a problem, however, because it represents departure from their normal use of smaller ULD's. They require different handling equipment. The intermodal advantage lies in the off-airport consolidation/break bulk operation which allows the container to bypass the internal terminal operations on the airport. The container adaptability to a trailer means that it is easily transportable to and from the airport. Cube utilization is directly related to the stuffing/stripping function. Studies (ref. 42) indicate that: (1) cube utilization is 8 x 4 x 10-foot (2.44 x 2.44 x 3-meter) M-1 modules may be as much as 10 percent greater than that of 88 x 125-inch (2.24 x 3.175-meter) contoured igloos; (2) containers exhibit a cube utilization that may be up to 10 percent greater than that for pallets of the same shape; and (3) little gain in cube utilization is ralized in module lengths greater than 20'. A more recent quantification states that the 20-foot (6.1-meter) M-2 container provides about 8 percent greater cube utilization than two 96 x 96 x 125-inch (2.44 x 2.44 x 3.175-meter) M-1 containers, even though the internl volumes are essentially the same. Certanly shipper-packed, routine, large-volume container loads (M-2 or larger) should maximize the stuffing efficiency/cube utilization in those cases where shipper packaging and internal container dimensions are compatible.

- Surface Transport - The pick-up and delivery function is handled routinely with the container on a 20-foot (6.1-meter) container chassis which interfaces with and locks to the four lower corner fittings of the container. Two containers can be transported on a 40-foot (12.2-meter) chassis. The PU&D charges for moving a 20-foot

(6.1-meter) chassis with container are generally the same as for moving a 40-foot (12.2-meter) rig. Double-bottom rigs, where legal, are helpful in increasing tractor and tractor driver productivity.

Since the smaller air containers, especially the shaped containers, are much less efficiently handled in ground transport, they are kept near to or on the airport. These latter have no intermodal potential.

- Air Cargo Terminal Handling - Most air cargo terminal facilities have been designed for handling of lower lobe containers and main deck igloos and pallets with base dimensions no larger than 96 x 125-inch (2.44 x 3.175-meter). In general, current carrier plans do not encompass modifying or expanding facilities for in-terminal handling of 20-foot (6.1-meter) containers. This may reflect a wait-and-see attitude that significant growth in 20-foot (6.1-meter) container traffic is imminent. However, in the intermodal scheme of things the 20-foot (6.1-meter) container is normally shipper-packed and, therefore, bypasses the in-terminal functions and equipment except for the processing of a single air waybill.

  One carrier, substantially equipped to routinely handled M-2 containers, is Lufthansa. This carrier's modern facility is euipped to nose-load with automated equipment and has installed in-terminal equipment of the stacker variety capable of vertical cellular storage of 20-foot (6.1-meter) containers.

- Aircraft Loading/Unloading - A variety of mobile equipment items have been developed to support 20-foot (6.1-meter) container loading on the 747F main deck. These include: (1) mobile straddle cranes for transferring containers between storage yard and ISO chassis, yard transporter and weigh scales, (2) transporter vehicles which move containers between the terminal or outside marshalling yard and the airplane, and (3) main deck scissors or poster loaders capable of elevating 30,000 to 72,000-pound (13,600 to 32,660 kg) to a height of 18-feet (5.5 meters) for interface with nose or side-door locations. There are few fixed nose-in loading equipment set-ups in the industry. American Airlines has procured and set in operation five Renner mobile straddle cranes. These top-lift devices have a capacity for lifting/transporting 64,000-pounds (29,030 kg) and are capable of transferring outsize cargo as well as containers.

Logistic Aspects: Studies and experience show that pooling arrangements minimize the problems associated with repositioning of intermodal containers through multiple usage. These arrangements also enhance container availability. Standard marine container pooling arrangements today make it possible to lease containers (and chassis) on a short-term basis and return them to pools located throughout the world at a much lower cost than would be required to own the same peak container capacity.

At this stage in the development and use of 20-foot (6.1-meter) air containers, the four airlines (Air France, Lufthansa, American, and Seaboard World) which regularly carry M-2 containers in their 747F's generally maintain control of the units within their own system. Each carrier has had problems unique to its operation; however, these are being solved with experience. Control seems to be the most common problem.

The system-to-linehaul ratio of 20-foot (6.1-meter) air containers is about 9 to 1, compared with the marine container ratio of 3 to 1. The marine container ratio is increasing due to longer linehaul distances and storage use as temporary warsehouses. The appreciably larger M-2 container ratio is a result of the much shorter air linehaul time as compared with a time of similar length for the ground segments of the total trip. The shipper via air in M-2 containers can also leave the container on chassis and use it as a temporary warehouse, although he will incur rental charges after 48 hours if he does not own the container and chassis. The lessor pooling approach will probably be initiated later as the needs of this new area of intermodal containerization expand.

In practice, an M-2 air container may be expected to turn over twice a week, whereas ISO surface mode containers are turning over aproximately twice a month. This 4 to 1 ratio ratio can produce air carrier revenues of a magnitude of $20,000 monthly as opposed to surface carrier revenues of $20,000 yearly. Therefore, higher revenues as well as higher costs push the air carrier to seek out shippers who want to "move the shipment" and not the shipper who wants to "warehouse the shipment." Container utilization is very critical in these bypass systems of shipper-packed M-2 containers. An extra day at the shipper and an extra day at the consignee will kill the ability to turn the container over twice in one week.

Government Positions and Involvements: In August 1973, Robert Redding, then Director of the DOT Office of Facilitation, said (ref. 43), "Secretary Brinegar is today equally convinced that transportation should be viewed in an intermodal sense, and should not be considered separately in terms of air, highway, pipeline, rail or water transport ... through the combined efforts, cooperation and coordination of all the elements of industry concerned, and the government, the time will come when a cargo plane will take a load of big intermodal containers and trailers, and deliver them to any place in the world just as easy as a plane today can deliver to the Nashville Airport a box of orchids from Honolulu." Also, "This is air cargo of tomorow. It is an indispensible part of the true intermodal movement of goods ... The challenge is to make it happen without too much delay."

Coincidentally, the time did come when, as a part of Project INTACT, a big aircraft did take a load of big 8 x 8.5 x 40-foot (2.44 x 2.6 x 12.2-meter) intermodal containers and trailer and delivered them to the Nashville Airport (ref. 13). The time was October 1975.

When the civil/commercial air cargo industry slowly courses its way towards an intermodal system built around the M-2 Type B 20-foot (6.1-meter) container and the 747F aircraft, the U.S. Air Force points to an increased intermodal capability based upon the ability to handle and transport the more numerous and available ISO marine intermodal containers. As previously stated, the marine intermodal containers are indeed already carried on slave pallets/platforms in rather limited quantities. Further large transport aircraft study guidelines (CXX, ATLAS, Innovative Aircraft) have consistently specified a capability for handling the ISO land-sea container - variously sized from 8 x 8 x 20 feet (2.44 x 2.44 x 6.1-meter) to 8 x 9.5 x 40-foot (2.44 x 2.9 x 12.2-meters) ASD (Aeronautical Systems Division) of the Air Force has published several technical reports (ref. 43 and 44) on the subject of USAF cargo airlift and intermodal (ISO marine/land-sea) containerization.

An increased degree of commonality of requirements between the civil and the military relative to future large transport aircraft has been espoused for several years by leaders in both fields. An enlarged market base would afford savings to all buyers. The goal remains, and current positions are perhaps closer than ever before. However, such items as vehicular floors required by the military rankle some of the civil carriers. Smaller differences such as the "which intermodal container" difference can possibly be reconciled by continuing the slave pallet/platform handling concept for the loading and transport of ISO land-sea container. Most civil carriers can be expected to carry the heavy ISO marine container only on a heavy slave pallet in an emergency or when under CRAF, Civil Reserve Air Fleet, recall (which is also an emergency). The military policy towards intermodal containerization would seem to project an increased demand for the carriage of these containers - an increase to the point of their carriage becoming routine. When, and if, their carriage becomes routine, it would appear that the ISO marine-container-on-slave-pallet transport scheme leaves much to be desired, and other loading concepts should be considered. The problem of the apparent strength deficiency in ISO land-sea containers for air load conditions must be resolved; it is entirely unsatisfactory not only to have to restrain the box within the aircraft but also to "reinforce" it. This container, of course, can be operated with a derated payload which will make its sides, front, and rear adequate. However, there is no similar easy answer to the "up" restraint inadequacy.

The current generation of civil, wide-body aircraft are not configured (in their present form) to promote intermodality. To date, air containers have been optimized to the aircraft, and aircraft have been optimized to the passenger. The DC-10, L-1011, and A-300 wide-body aircraft are insufficiently wide to accept two side-by-side rows of M-2 containers. As a minimum, the upper outboard edges of the containers must be scarfed. The 747F can accept M-2 containers in double-row fashion, but for 8.5-foot (2.6-meter) container heights, the container must be similarly shaped as above for clearance.

Pertinent DOD direction and instruction (ref. 33 and 34), previously mentioned, rather firmly state the military logistic-distribution needs are deeply dependent upon and intertwined with international standardization and intermodal containerization.

The primary customer of the U.S. Air Force is the U.S. Army. The Air Force itself is not highly motivated to containerization and especially not to large containerization. However, they are pleased to serve their customers needs. No doubt the Army has plenty of containerizable cargo for contingency situations. In the civil air sector, the primary inhibitor to the growth of containerization to date is the insufficiency in volume of routine large truck load/container load shipments where such large shipments both originate and terminate from single parties. Military air is moving to containerization and intermodality, but like the civil air cargo operates, this movement is slowed because the customer has not yet tendered routine, large-volume containerized cargo nor established an absolute hard-and-fast requirement for volume flows.

Case Study Results on Containerization and Intermodalism

Questions were posed in CLASS Case Study Shipper Books 1 and 3 and in the Carrier Book which provide industry views on containerization, intermodality, and related subjects. An Advanced Air Cargo System (AACS) was described for the participants. The participants were requested to state their views regarding the rate of containerization in influencing increased future use of air shipments. This included: the advantages and disadvantages of air freight containerization, the importance of intermodal capability, and opinions and the size of present air mode containers. The results, and accompanying comments, are presented in the following paragraphs. Not all participants submitted comments, but some returned more than one comment.

Container Size/Dimensions - Container size was the subject of more comments than any other physical characteristic. The following list of participants' comments indicate their desire for larger containers for air cargo.

COMMENT	COUNT	NUMBER OF COMPANIES MAKING COMMENT
Maximum legally allowable container dimensions	6	6
Containers larger than present highway limits, 8 ft. (2.44 meters) wide, 13.5 ft. (4.1 meters) high; i.e., relax present limits.	3	3
Increased container dimensions (not specified)	3	3
High cube, 8.5 ft. (2.6 meter) or higher	7	7

Containers of 45 feet (13.7 meters) long, like some highway van trailers.	6	6
Regular 40-foot (12.2-meter) long dry van-sized containers.	7	7
Regular 20-foot (6.1-meter) long dry van-sized containes	6	6
Containers within containers or smaller modular container to fit larger containers	5	5
Containers in 10-foot (3.05-meter) lengths	4	4
Container must accommodate multiple full pallet loads	3	3
Standardization of container	2	2
Specialized high-cube containers to accommodate shipments of 7-10 motor vehicles	1	1
Miscellaneous comments insufficient to conclude a significant trend.	6	6

Over 70 percent of the comments about size specified that containers for the AACS should be at least as large as 8 x 8 x 20-feet (2.44 x 2.44 x 6.1 meters). Over 50 percent desired 40-foot (12.2-meter) long or longer containers. Each comment on a particular subject was made by separate companies as indicted in the above list under the column heading, "Number of Companies Making Comment." As noted previously, some companies made comments on several subjects related to container dimensions. In the comments tabulated above, 24 companies provided the 59 separate comments. Twenty-one, or almost 90 percent, of the companies commented that they desire large containers for the AACS.

Only a few comments could be braodly interpreted to show acceptance of current air freight container physical features other than, perhaps, the M-2 container. Interestingly, several shippers emphasized that 8.5-foot (2.6-meter) or higher containers provide a 50 percent increase in the product units loaded, compared with 8-foot (2.44-meter) containers. The push for increasing the size of future containers by so many shippers illustrates their need for volume as they cube out containers in much the same manner as freighter aircraft are cubed out before achieving payload weight limits.

Several shippers spoke to 10-foot (3.05-meter) modular containers and/or internal modularity.

Container Special Capabilities/Features: The majority of these comments relate to requirements for refrigerated, insulated, heated, vibration- or chatter-resistant, or heavy/concentrated load strength capabilities. Thirty-four comments were provided by 19 companies. About one-third of the comments indicate that 58 percent of the companies desire heat and/or refrigeration, insulation or waterproofing. Temperature control capability adds significant weight to the container as well as increased cost. These features also sometimes reduce the cube available in the containers due to insulation and equiment. Almost 15 percent of the comments indicated a need for load restraint, load protection, or load isolation devices. Four specific comments state that the container should be of sufficient strength to handle heavy machinery parts and components of odd size and shape, American Airlines M-2's will not.

Almost 40 percent of the comments relate to specialized requirements of shippers such as internal floor conveyors, external fork lift fittings, bulk loading/unloading capability, internal double decking, hydraulic lift tail gates, security locks, and no roll-up doors. These comments are tabulated below.

COMMENT (CONTAINER FEATURE DESIRED)	COUNT	NO OF COMPANIES COMMENTING
Protective Service (heat, refrigeration, insulation, waterproof)	11	11
Load-restraint, load protection, or load isolation	5	5
Sufficient strength to handle heavy loads of odd size and shape	4	4
Rapid loading/unloading devices	3	3
Internal double-decking	2	2
Other specialized requirements - - hydraulic tail gate lifts - bulk loading/unloading - no roll-up doors - floor conveyors - fork lift fittings - compatible with rail car rails - removable climate control units - door-to-door security	9	6

Degree of Intermodality: Seventy-six percent of the companies commenting on intermodality desire to see all-mode (air-sea-rail-truck) intermodality. Thirteen percent feel that air-truck intermodality will be sufficient and adequate. The comments and number of comparisons providing comments are shown below:

COMMENTS	COUNT	NO. OF COMPANIES COMMENTING
All Modes	11	10
Air/Truck Only	2	2
Other	2	2

Other Physical Characteristics: The participants also provided comments on the other desired physical characteristics listed below.

COMMENTS	COUNT	NO. OF COMPANIES COMMENTING
Terminal facilities	9	7
Aircraft characteristics	8	7
Interface with shipping, receiving, storage	7	7
Container mounting of hauling vehicle	4	4

The comments were made in response to a question that asked the participants to indicate specific physical characteristics of the AACS that would be important to them. More companies (13) were interested in intermodality than in other physical characteristics such as terminal facilities (7 companies), aircraft characteristics (7 companies), interface with shipping, receiving, storage or container mounting of hauling vehicles (4 companies).

Advantages and Disadvantages of Containerization: A series of questions requested the participants to express their viewpoint based on their experience as to the advantages and disadvantages of containers. The tabulation of comments provided on the advantage is shown below.

COMMENT	COUNT	NO. OF COMPANIES COMMENTING
Reduces Loss, Damage, Perishabilty	26	16
Reduces Physical Distribution Functional Costs, Handling, Packaging		

Inventories, Labor	19	12
Reduces Transportation Costs	14	13
Improves Transportation Efficiency	11	9
Simplifies Transportation and Distribution	7	6
Reduces Transit Time	7	7

The participants' comments on the disadvantages of containerization are noted below.

COMMENTS	COUNT	NO. OF COMPANIES COMMENTING
Equivalent Capacity, Convenience or Utilization, Too Small, Difficult to Handle, Odd Sizes	9	8
Equipment Unavailability	9	7
High Costs, Capital Investments	8	6
Limited Geographic Scope Limited Origin - Destinations, Required Secondary Feeder System	5	4
Container Utilization Constraints Can't Achieve Weight Minimums	4	3
Equipment Features, No Tiedowns, No Padding Condensation	3	2
Terminal Handling Problems Marshalling Time, Storage Space, Break Bulk Delays	3	3

Although the count of comments on advantages outweighs the disadvantages two to one (84 to 41), it is more significant to note that many of the disadvantages relate to the fact that the available containers do not have the desired characteristics. For example, disadvantages cited most often, equipment capacity convenience or utilization, relate to limitations cited by the participants in the questions about desired characteristics or features of containers, not particularly to the disadvantages of containerization itself.

Opinion On Present Air Containers: The participants were asked to give their opinion about the air cargo containers that are currently available. The tabulation of their comments is shown below.

Opinion of Present Air Containers - Unfavorable:

COMMENT	COUNT	NO. OF COMPANIES COMMENTING
Container Size and Shape	35	20
Other Physical Limitations, Weight Limitations, Too Flimsy	7	3
Equipment Un-Availability	6	5
Limited Intermodality	3	3

Adverse opinions are predominantly directed at the size and shape of the present air containers by shippers/consignees who routinely make and receive large shipments. A typical large volume shipper commented: "We tried to use present air carrier containers (igloos) but couldn't get a trucker to handle them, couldn't get them high enough to our dock ..." Another stated: "It would be an inhibiting factor for air freight if we needed to construct special facilities to handle air containers. It would also reduce our productively ... and ... It would be an advantage to shippers if future air freight containers could be dropped off at the shipper's dock on bogies so that adequate packing and load generation can take place."

Opinion of Present Air Containers - Favorable: There were just eight favorable responses spread over such factors as: less damage, excellent for small package freight, and money saver in reduced packaging costs. The eight comments were provided by six companies.

Importance of Fully Intermodal Containers for AACS: Participants were requested to rate on a scale of zero (unimportant) to 5 (essential) their opinion of how important it is that future air system containers be fully intermodal. The number of responses for each numerical rating of importance is shown in Figure IV-4;; the average is 4.03. A comparison question asked the participants to rate on the same scale, 0 to 5, the importance that containerization procedures at shipper/consignee facilities be compatible with surface-freight processing procedures. The number of responses for each numerical rating for this question are shown in Figure IV-5; the average rating for these responses is 4.13. The responding shippers here feels strongly that the future air system should use intermodal containers which are fully compatible with surface-freight processing means and methods. Reduced handling time and cost, increased cargo protection, and need for unit load from origin to destination were the main supportive citations. Figures IV-4 and IV-5 clearly shows the shippers' insistence that fully intermodal containers are essential and that they feel the air freight system should be compatible with the surface system.

Company Position re Shipper vs Carrier Stuffing of Containers: The opinion expressed by 63 percent of the companies is that shipper loading is

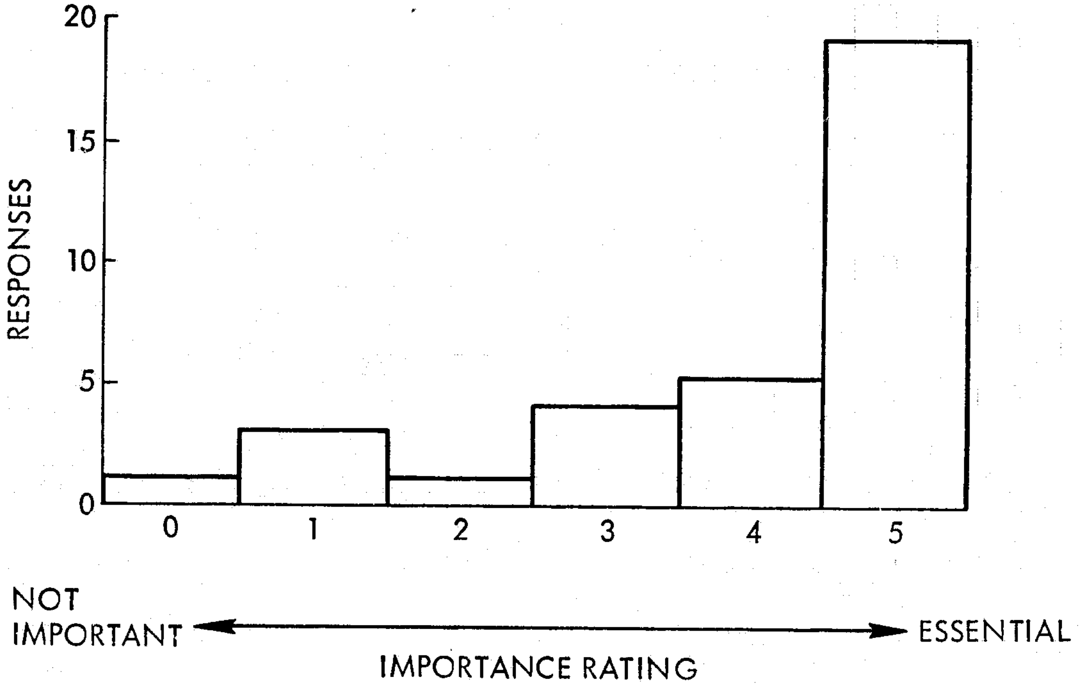


FIGURE IV-4. IMPORTANCE OF FULLY INTERMODAL CONTAINERS (FUTURE AIR SYSTEM)

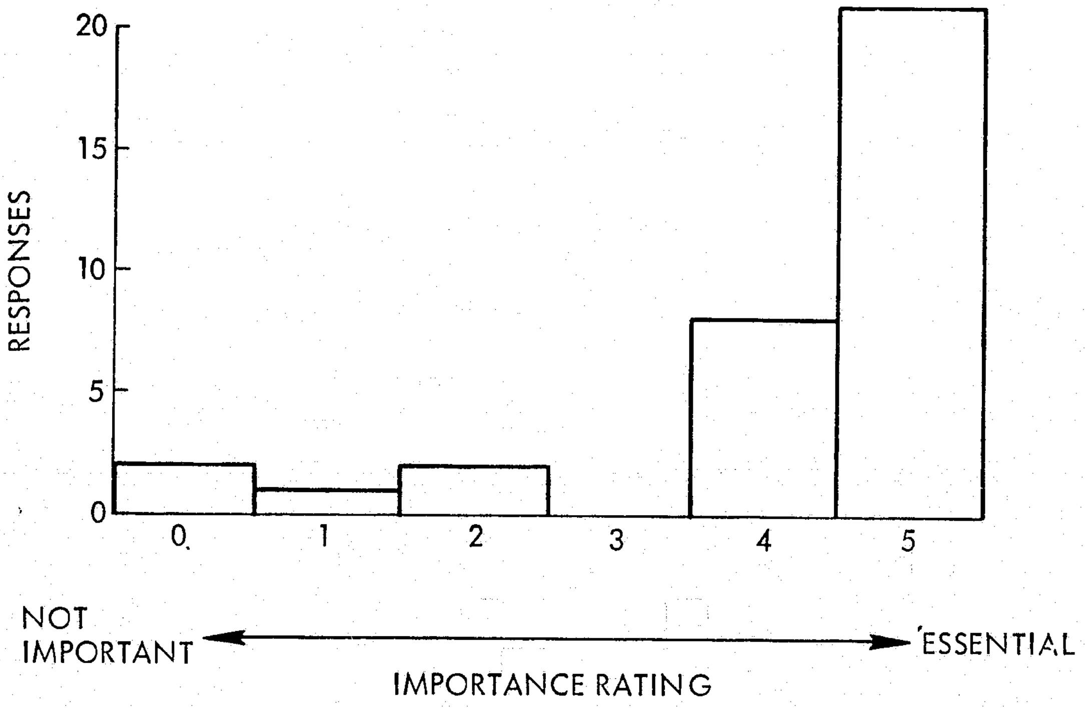


FIGURE IV-5. IMPORTANCE OF CONTAINERIZATION PROCEDURE COMPATIBILITY SHIPPER/CONSIGNEE VS. SURFACE CARRIER either highly desirable or imperative. Eleven percent were neutral and eleven percent favored carrier loading. Majority comments felt that shippers are more familiar with proper handling and loading of their material, and best utilization of alternative types of equipment. Shipper loading also helps to ensure prompter dispatch of loaded containers.

Container Acquisition and Maintenance Costs

Due to the limited quantities produced of the new M-2 air containers, the unit cost for the first few containers has been about $8500 to $9000, roughly three to four times the cost of 20-foot (6.1-meter) ISO marine containers. In the following comparison between air and surface mode (marine) containers, the quantities of air containers in a production run are obviously minimum in scale compared with the large procurement quantities of the latter. Acquisition costs are in 1977 dollars.

20-Foot Length Container Cost/Year	Acquisition Cost $/Unit	Service	Avg. Maint. Cost % Acq. Life/Years
Air (Type B)	8000	5 est	25%/year/9/
Marine - Alum. Alloy	3000-3200	10-15	4-7%/year
Marine - Steel	2200-2400	10-15	4-7%/year

A higher production run on air containers in same year dollars might reduce this figure to $7000. Further reductions are unlikely, as the lighter weight and higher strength materials and alloys will not result in a substantial further decrease.

A nose-loading 747F can handle as many as thirteen M-2 containers, and nine can be handled in a side loader. With a need for nine or more (ref. 32) containers in the system for each in the air, one 747F aircraft could require an inventory of from 80 to 120 containers at a cost of $650,000 to $1,000,000. Costs like these both slow down the introduction of these containers, and cause the carriers to look to lessors.

Surface mode container maintenance does not accrue on a container per year basis but on a per/incident basis. Average cost/container/year as given are based on the year's maintenance cost for a fleet of containers. These containers are generally long lived. Richard H. Finn of ICS, Integrated Container System, says (ref. 45), "We're not scrapping a lot. We'd rather recondition a container for $400 to $500 and keep it in the fleet for another eight to 10 years." Another executive from the field said in 1977, "There are more than 1,500,000 cargo containers in use in the world at this time... It would be reasonable to assume that as many as 105,000 containers are overdue for retirement, which is only seven percent of the total number presently in service ... Now you can't find hide nor hair of a used container..."

Indirect Operating Costs (IOC's), which include the ground handling costs for cargo, are addresed separately in Section V of this report. In that discussion, a comparison is made between conventional air cargo system and intermodal air cargo systems. The former covers bulk and small, odd-shaped container loads substantially involved with today's on-airport facilities, equipment and manpower. The latter is for routine large shipments consolidated off airport and requiring only an austere minimum of on-airport support for the handling of by-pass containers. In the cargo terminal discussion in Section I covering current air cargo systems, additional data are provided relative to containerization and related labor equipment and facilities costs.

Operational Aspects

Air cargo, is handled in many different fashions.

The type and levels of service, along with the rates, vary considerably. Containerization is integral to the operation of some schemes but not others. Table IV-4 is presented to show a spectrum of air cargo/air express handling concepts. It is acknowledged that some concepts presented are simply appendages to the more basic systems, providing some form of specialized service. Two of the three specialized parcel-handling schemes, the small package and Federal Express, do not use any part of the regular air-carrier type of cargo system. The contract charters may use equipment identical to that of a scheduled air freight carrier, but they operate irregularly without cargo terminals and frequently from non-hub airports. A short description of each handling system is presented below to amplify the content of Table IV-4.

Small Package Expedited Dispatch Service - In this system the shipper delivers the package directly to the passenger check-in counter area, prepays or charges the fee, and is assured the package will move out on the first passenger aircraft to the particular destination. At destination, it is incumbent upon the consignee to pick up his package at the passenger baggage area after notification by the shipper. The service is rather analogous to the package system provided by Greyhound and Trailways bus lines.

Federal Express - This premium door-to-door small package service operates entirely outside of the air carrier field. The system operates on a central hub (Memphis, Tenn.) basis with all packages moving through the central hub. Federal Express picks up the packages at one of 75 cities (in 1976), puts it on their aircraft, flies it to Memphis, puts it through their hub terminal, flies it to the destination city, puts it in a truck, and delivers it. The

TABLE IV-4
AIR CARGO/AIR FREIGHT SERVICE SYSTEMS

Air Freight Package Handling System Description	Package Size Limit	Type of Aircraft	PU&D Included	Pick-Up Time of Day	Level of Service	Rates	Container By-Pass Term	Remarks
Small Package Expedited Dispatch Service	Parcel	Sched Pax or Combi	No	NA	Next Pax Flt Out	Premium - Air Parcel	NA	Utilizes Air Carrier Baggage System
Federal Express	Packet or Small Parcel	Falcon Jets & Other	Yes	Daytime	Overnight & 2nd Day	Premium - Air Parcel	NA	Private Airline Using Central Hub Distribution Concept
UPS Bluelabel	Parcel	Sched Freighter	Yes	Daytime	2nd Day or Later	Premium - Air Parcel	Yes	Air Parcel Post - Limited Geographically
Priority Air Freight	LD or Main Deck ULD	Sched Combi or Freighter	No	NA	Next Combi Out	Premium	No	Must be Tendered X-Minutes Prior to Flight
Air Freight Forwarder	LD or Main Deck ULD	Sched Combi or Freighter	Yes	Both Daytime & Pickup at End of Dayshift	Conventional or Daylight Overnight or 2nd Day	Regular or Discount	Frequently	Level of Service Hurt Badly by Shrinkage of All-Cargo Aircraft Service
Daylight Rate Freight	LD ULD	Sched Combi	Not by Carrier	Daytime Tendering Only	2nd Day Delivery	Discount (Incentive)	Sometimes	Born of the Excess Belly Capacity in Wide-Body Bellies
Conventional All-Cargo Aircraft	Main Deck ULD	Sched Freighter	Not by Carrier	At End of Day Shift	Overnight	Regular	Sometimes	Current All Freighter Service, Generally 707, DC-8 or 747 Equipment
Advanced Intermodal Air Cargo	8 x 8.5' or Higher Lengths to 40'	Sched Freighter	Not by Carrier	As Required	Overnight	Regular - VOL Incentives	Always	Future System With Undefined Future Aircraft
Charters	Aircraft Compartment	Non-Sched Freighter	No	NA	Special	Negotiated	NA	Can be Performed by Scheds but More Commonly by Non-Sched (Supplementals)

IN ADDITION, THE U. S. POST OFFICE OFFER AN OVERNIGHT AIR PARCEL POST SERVICE TO/FROM A LIMITED NUMBER OF CITIES AND POPULATION CENTERS. ALSO, THE U. S. MILITARY HAS SYSTEMS FOR CHANNEL TRAFFIC AS SPECIAL AIR MISSIONS AS WELL AS CIVIL CONTRACTED LOGAIR AND QUICK TRANS.

hub system essentially limits the total system to a single cargo terminal although the operation serves many cities. Federal Express does contemplate the establishment of some supplementary hubs and is using some substantially larger aircraft than the Falcon jets it started with. Because Federal operates its flights at night it can consistently serve all its markets 100 percent overnight. However, it now provides several grades of service, and a special parts service as well. The air cargo forwarder has seen his ability to serve many non-major hub airport cities diminish with the reduction in flight frequencies, and especially in all-freighter aircraft (which flew at night). This fact, plus the demise of Air Express, has fostered the growth of Federal Express.

UPS "Bluelabel" - UPS makes this 2nd-day delivery service available between certain geographical areas. It uses its own existing pick-up and delivery and processing hubs with the substitution of an air carrier for the line haul in lieu of the normal surface movement. UPS consolidates most of that which moves in container load lots. Package and shipment size are limited, but UPS uses the largest suitable ULD's in their shipping.

Priority Air Freight - This is an air carrier service provided by some carriers to expedite the handling of emergency freight much in the same manner as that of the small package service. The shipment must be taken to the air carrier on-airport freight terminal (in lieu of passenger terminal) in ample time to catch the next flight out. This is a premium service.

Air Freight Forwarder - The air freight forwarder is the major shipper using air carrier services. The forwarder is the pick-up and delivery man and consolidator for many small shippers. For those shipper-stuffed containers, the air carrier provides just the line-haul miles. Some air freight forwarders have contracted for substantial charter flight networks run at night. These ton-miles are bought in an attempt to keep up the level of service to points which have lost freighter service. Containers are stuffed very efficiently, since the forwarder makes most of his money from taking multiple shipments and consolidating them.

Daylight Rate Freight - The introduction of so many wide-bodied passenger jets suddenly brought forth an excess of belly cargo capacity. Daylight rates have been effected to provide incentives in the development of a market to fill these bellies. The freight is tendered to the carrier during "daylight" hours (normal working day), and the carrier handles this freight in a non-priority, second-day delivery fashion. The service is offered at a discount and does not necessarily pay its own way. Substantially, all this cargo is containerized in the LD family of containers.

Conventional All-Cargo - In this conventional or regular air freight system employing all-cargo aircraft (and some pax/belly combis which fly at night), the cargo is picked up and/or tendered at the end of the regular working day, say between 5 and 8 p.m. The freighters fly beginning at sometimes after 10 p.m. and generally arrive before dawn. The high level of service basically calls for availability at the air terminal dock by around 9 a.m. and delivery during the day. ULD's used in this service cover the whole air family, but the emphasis is on the large main deck units, "A" containers or LD-7, -11's for narrow-body main decks, and the M-1, and M-2 for wide-body main decks. LD units are used in wide-body bellies. This service includes that 747 service with 20-foot (6.1-meter) containers as performed by Seaboard World, Lufthansa, American, and Air France. Rates are what must be called regular or standard, meaning they are neither premium nor are they discounted.

Advanced Intermodal Air Cargo - This future system, for 1990 and beyond, is described in the "white" case study book, furnished all case study participants, and entitled, "1990 Transportation Scenario and Advanced Intermodal Air Cargo System Concept" (Appendix I-D). In brief, the system will use an advanced-technology air freighter optimized for cargo carriage. The freighter will serve major domestic and international trade routes, primarily on route distances of 800 miles (1288 kilometers) or greater. The aircraft will operate from regional cargo airport centers, which may be separated from congested passenger airports. The system will provide mass air movements on routine schedules consistent with the needs of large-volume shippers. The system will be coordinated surface-to-air-to -surface operation. The motor carrier industry will perform connecting services between air mode shippers as well as connecting services with rail and water modes. The aircraft will have full intermodal compatibility with the surface transportation segments. A family of all mode ULD's will have been developed which are suitable for both air and surface use. Those load devices will be interchangeable among all modes and not captive to any mode. Surface carriers will have the option of offering air service to their customers as a segment in a door-to-door through movement both domestically and internationally.

Charter - Charter flights are contracted for by the aircraft load. Charters are a mixed bag, as the cargo may be anything from animals to prefab buildings to outsize machinery, and is not necessarily palletized or containerized. It is an irregular, non-scheduled type of air cargo business, and "rates" is an inappropriate term, since charters are bid/negotiated as each need arises. Both narrow-body and wide-body aircraft are used in this work.

Summary of Findings

Air containers come in many sizes and shapes. These containers are generally built to maximize the use of the cube of the aircraft. ISO marine containers are of rectangular shape and in sizes which maximize their volumetric efficiency over the road. The over-the-road movement is the one type of movement which provides connectivity between modes and which is common to all cargo movements. Since most air containers are very inefficient for use in ground transportation, they are not used off-airport in ground transportation.

Economical ground handling and off-airport transport of large shipments of air cargo is dependent upon containerization. The current non-intermodal (on-airport utilization) air freight system is estimated (ref. 32) to require four additional hours of airline labor and eight additional hours of truckman labor (includes pick-up and delivery) when compared to the intermodal "bypass" container airfreight system. The comparison addresses the implementation and use of the 8 x 8 x 20-foot (2.44 x 2.44 x 6.1-meter) M-2 container.

The new M-2 air container is similar to the 20-foot (6.1-meter) ISO marine container. All M-2 containers are flush bottomed for roller-conveyor compatibility. All ISO marine containers have non-flush bottoms with protruding corner fittings and incrementally spaced cross-members. The Type B M-2 container has corner fittings compatible with the same lift/handling equipment as the ISO marine container. Certain structural differences exist in the requirements for the two types of containers, but other than the bottom differences, the largest variance shows up in the tare weight comparison. The ISO marine (surface mode) containers outweigh the current M-2 containers by a factor of 1.5 to 2.5.

Surface mode containers size trends lengths stabilized at approximately 60 percent (of the total) in 20-foot (6.1-meter) and 40 percent in 40-foot (12.2-meter) length. Height trends show continuance on purchasing some quantities of 9.6-foot (2.9-meter) containers in the 40-foot (12.2-meter) length. Ninety- five percent of the 40-foot (12.2-meter) length containers are 8.6-foot (2.6-meters) high or taller. In the 20-foot (6.1-meter) length, where nearly all early procurement was of the 8-foot (2.44-meter) height, all new procurement is for the taller 8.5-foot (2.6-meter) height. Growth in width is regulatorily restrained, as in 1976 just four states allowed truck trailer widths in excess of 8-feet (2.44-meters). Similarly heights above 9.5-feet (2.9-meters) are dependent upon lower-height (smaller wheel/tire diameter) chassis as, again, heights greater than 13.5 feet (4.1-meters) over-the-road are permitted in only four states.

The group of shippers and surface carriers represented in the CLASS case studies were generally disparaging of the present air containers. Complaints were strong with expressions of distaste for size, shape, and incompatibility with existing ground transportation equipment and manufacturer/shipper facility. Some promise was given for the M-2 container, although one shipper expressly stated it was too small. Concensus was expressed for large if not very large containers of greater than 8-foot (2.44-meter) heights and sizes - up to "larger than today's highway limits." Compatibility with ground transportation systems and shipper facilities is understood.

No comments were received concerning max weight capability limitations although several shippers used case study commodities whose densities exceed the design densities of both the air and surface (ISO marine) containers. Essentially, intermodality in the airfreight scheme involves a smoothly operating system providing dock-to-dock delivery of intermodal containers anywhere in the world in two to three days. The technology needed to synthesize such a system is available as much can be borrowed from the surface transportation industry.

Serious problems exist internationally with respect to a lack of decent rate incentives for containers. Incongruously, it is often less expensive to ship goods alone (loose), under specific commodity tariffs, than to containerize under FAK container tariffs. Domestically, large containers which are captive to the all-cargo aircraft are at a disadvantage to compete in some markets with fully allocated costs against many promotional/by-product rates such as daylight container rates.

Near-term developments which will aid in development and furtherment of intermodal schemes are the increasingly high weight breaks for large, king-sized shipments tendered in large, wide-body, main deck containers and contract pricing for multiple containers and/or blocked space.

Air containers are three to four times as expensive as surface containers, and they are expected to cost more to maintain and to have a shorter service life. However, the air container will be more productive per unit time for the air line-haul time versus surface line time. They cannot be expected to have a advantage during ground transport and handling time, but due to their higher cost, they are much less likely to be allowed to sit at shipper/consignee docks performing warehouse functions.

Containerization of shipper-stuffed loads in large intermodal containers using austere on-airport handling and aircraft interface equipment and terminal bypass procedure can put freight servicing/IOC costs in perspective, and provide a viable alternative for some shippers in the high in-terminal handling costs reportedly running to half of the freight bill paid.

This report expresses the result that the air cargo industry should be responsive to the needs of the high volume shipper, and should engender as much compatibility as possible with the surface mode container transportation sytem which presently represents:

- Over 1.5 million containers
- Over 400,000 container cells on ships
- Vessels carrying 2000 TEU's at speeds in excess of 25K
- In-port turn-arounds measured in fractions of days
- Advantages of use of pooled equipment
- Over-the-road suitability

In containerization, and the related ramp and aircraft interface equipent, progress certainly is not awaiting a technological breakthrough. The container is, indeed, the key element in an intermodal freight system and in an advanced air cargo system but the real missing ingredient is the sufficiency of routine large-volume shipments, with shipment volumes of a size to originate container load shipments to single consignees. Much of the remainder of this report is directed toward this subject.

V - AIR CARGO SYSTEMS ANALYSIS

Introduction

This section analyzes interdependencies between air cargo volume, air cargo rates, costs of operations, service frequencies, and operator profitability. Not all of these relationships consist of first-order interdependencies; second; third, and higher-order interdependencies can also be found. While not all possible interdependencies are investigated in this analysis, it is necessary to control all factors systematically so that the analyses will not be contaminated by effects of interdependencies not under investigation in the specific instance.

The analytical tool used is a set of interrelated computer programs. The methodology used varies from task to task, but these details are not fundamental to understanding the systems analysis. Knowledge of the tool and the inputs used in the analysis is, however, fundamental to understanding and interpreting the results of the analysis. Therefore, descriptions of the set of computer programs and the scenarios on which these inputs are based are provided under Methodology. Subsequent subsections reference that description and explain the additional input and scenario changes that are made to investigate the various other relationships.

Methodology

Air Cargo Analysis System - The analysis system shown in Figure V-1 is a set of computer programs that represent many of the interdependencies between the parameters in air cargo operations. Information on candidate aircraft is developed in a generalized aircraft sizing program. The Aircraft Cost and the Direct Operating Cost programs provide the cost of manufacturing the aircraft and the direct operating cost for the candidate aircraft, respectively, based on the aircraft characteristics. The output of these programs and other data are the input to the linear program that characterizes a representative air cargo operation. The linear program provides the operating characteristics that maximize airline operator earnings. That is, activities that represent cargo airline operations combine the resources available for each specific situation to produce maximum earnings. Each solution becomes a data point to identify trends or sensitivities related to the particular interdependence under investigation.

One of the essential inputs, as shown in Figure V-1, is the air cargo demand, many of the interdependencies between elements in air cargo operations are inherent in the factors that characterize the demand. First, for each condition to be investigated, there is a specific volume or magnitude of

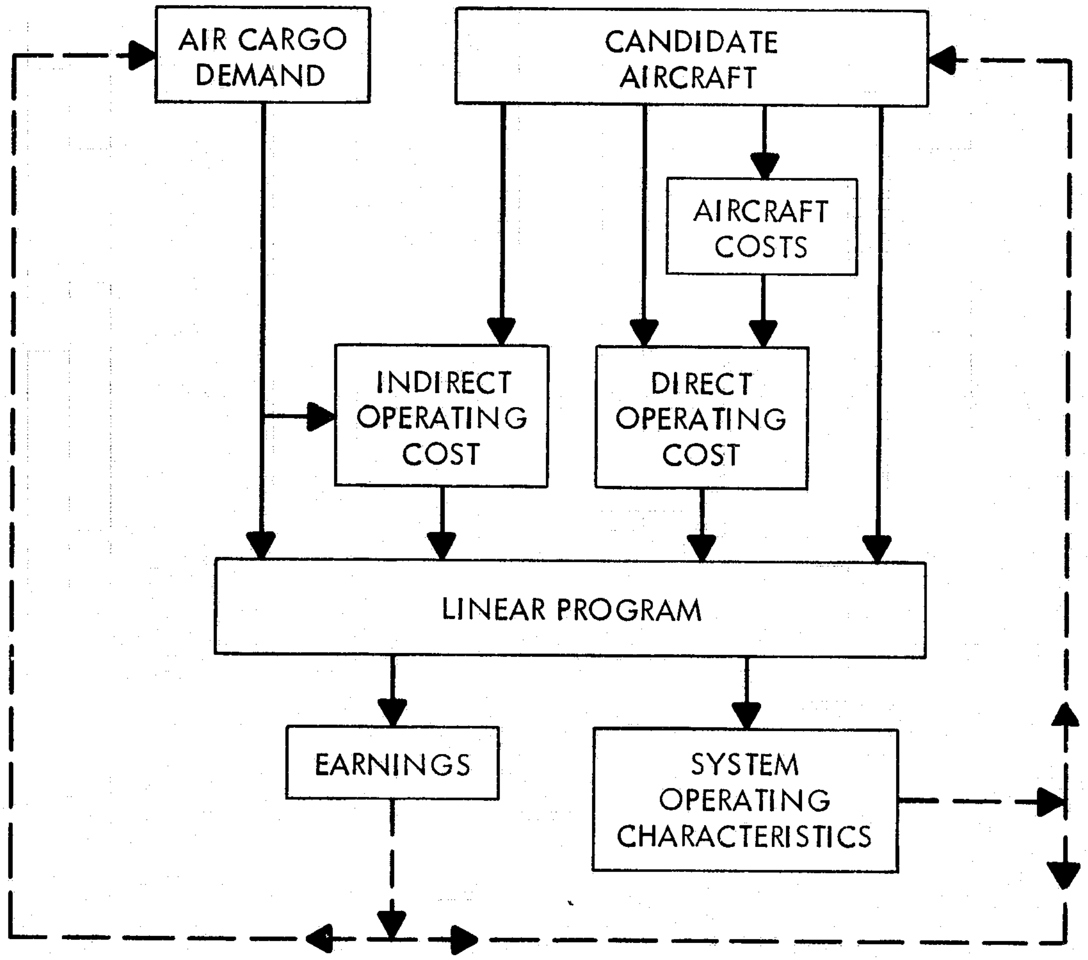


FIGURE V-1. AIR CARGO ANALYSIS SYSTEM

demand for air cargo transportation between specific points. This requires the development of a representative route system and forecasted volume of demand. Another factor that characterizes the demand is the frequency of service. The interdependency between frequency of service and demand volume is represented by a frequency-demand function that can be varied between boundaries. In addition to frequency of service, demand is interdependent with the payload capacity available on the routes. There must be sufficient aircraft capacity on each route to carry the demand; thus, a demand-capacity function is included in the demand inputs.

The rates to be charged for transporting the cargo between the points on the route network is also a factor in the demand function. The cost of operating the aircraft on each route is subtracted from the total revenue generated from transporting the cargo. The result is the earnings for that specific route.

In summary, the air cargo demand function in the air cargo analysis system shown in Figure V-1 consists of factors for volume, route network, frequency, capacity, and revenue.

The diagram in Figure V-1 has feedback to complete the loop analysis. The feedback is shown by broken lines to indicate that the system is operated open loop. That is, the adjustments to the input are not automatic; they are made manually on the basis of the trends shown by the output. In open-loop systems, the analysis proceeds in the following manner: A spectrum of inputs is selected such as the demand spectrum described and a series of candidate cycled several times to produce a series of outputs. These outputs are analyzed to identify trends and salient characteristics. Changes to the inputs may then be selected to investigate more thoroughly or perhaps to "fine tune" the system. The fundamental products are trends and sensitivities of specific functions to changes in certain variables.

In the following paragraphs, the technical matters concerned with the development of the spectrum of basic input data for the air cargo analysis system are described.

Candidate Aircraft - The characteristics of the candidate aircraft that were used on all the runs of the LP were determined by means of Lockheed's Generalized Aircraft Sizing Program (GASP). GASP is a comprehensive program for use in preliminary design and can provide much more detail information than is necessary for this project. Two families of high-technology transports were identified as candidate aircraft for this project, one to service the domestic network and a longer-range family to service the international market. The families of aircraft were selected by specifying certain mission requirements and establishing boundaries that, based on judgement, should have wide enough range to include the forecasted demand under the various scenarios for market growth that may be available. The prime mission parameters and the characteristics of the families of domestic and international aircraft selected are given in Table V-1E. While a great deal of information is developed about the candidate aircraft by the aircraft sizing computer program, the

TABLE V-1E. AIRCRAFT CHARACTERISTICS

A/C Designation	D-70	D-125	D-220	D-330
DOMESTIC				
Payload, Lb	71,000	125,000	220,000	330,000
TOGW, Lb	242,640	377,999	583,937	834,927
OWE, Lb	101,237	149,347	212,213	292,872
Unit Engine Wt, Lb	2,382	3,929	6,415	9,862
Unit Engine Thrust, Lb	17,041	26,485	40,791	59,585
Number of Engines	4	4	4	4
Crew Size	3	3	3	3
Range, Mi	3,450	3,450	3,450	3,450
Cruise Speed, M.	.85	.85	.85	.85
Takeoff Dist., Ft	8,000	8,000	8,000	8,000
INTERNATIONAL		I-125	I-220	I-330
Payload, Lb		125,000	220,000	330,000
TOGW, Lb		464,174	708,789	1,012,078
OWE, Lb		169,113	242,372	343,746
Unit Engine Wt., Lb		4,280	6,941	10,134
Unit Engine Thrust, Lb.		28,558	43,725	62,353
Number of Engines		4	4	4
Crew Size		3	3	3
Range, Mi.		5,500	5,500	5,500
Cruise Speed, M.		.85	.85	.85
Takeoff Distance, Ft.		10,000	10,000	10,000

TABLE V-1M. AIRCRAFT CHARACTERISTICS

A/C Designation	D-70	D-125	D-220	D-330
DOMESTIC				
Payload, Kg	31,950	56,250	99,000	148,500
TOGW, Kg	109,188	170,099	262,771	375,717
OWE, Kg	45,557	67,155	95,495	131,792
Unit Engine Wt, Kg	1,274	1,768	2,886	4,438
Unit Engine Thrust, Kg	7,668	11,018	18,356	26,813
Number of Engines	4	4	4	4
Crew Size	3	3	3	3
Range, Km	5,520	5,520	5,520	5,520
Cruise Speed, M.	.85	.85	.85	.85
Takeoff Dist. M	2,400	2,400	2,400	2,400

INTERNATIONAL	I-125	I-220	I-330
Payload, Kg	56,250	99,000	148,500
TOGW, Kg	208,878	318,955	455,435
OWE, Kg	76,100	109,067	154,685
Unit Engine Wt., Kg	1,926	3,123	4,560
Unit Engine Thrust, Kg	12,851	19,676	28,058
Number of Engines	4	4	4
Crew Size	3	3	3
Range, Km	8,800	8,800	8,800
Cruise Speed, M.	.85	.85	.85
Takeoff Distance, m.	3,000	3,000	3,000

fundamental aircraft information required for costing is the size of the aircraft and the level of technology. Another factor that affects aircraft costs is the production break-even quantity used in the costing program. The quantity of aircraft required to meet the market is a function of the size of the aircraft and the frequency of service required so there is a relationship between the aircraft payload and the quantity required to satisfy the air cargo demand.

Direct Operating Cost (DOC) is also calculated in a computer program. The calculations are based on the 1967 ATA method which was developed through the cooperation of Lockheed, Boeing, and Douglas (McDonnell-Douglas) (ref. 2).

Direct Operating Cost Elements: The DOC cost elements described in Ref. 2 are listed below:

1. Flying Operations
    - a. Flight Crew Costs
    - b. Fuel and Oil
    - c. Hull Insurance Costs
2. Direct Maintenance - Flight Equipment
    - a. Labor - Airplane
    - b. Material - Airplane
    - c. Labor - Engine
    - d. Material - Engine
    - e. Maintenance Burden
3. Depreciation - Flight Equipment
    - a. Total Aircraft Including Spares

Indirect Operating Costs (IOC) are a function of the aircraft type and the cargo flows and are calculated by a method developed by Lockheed (ref. 3). A complete description of IOC is given in a subsequent paragraph where the relationship between IOC elements and earnings will be evaluated. In the analysis of the impact of air crago volume on airline operator profitability, the IOC values used are representative of the scenario.

Linear Program - The objective function of the LP (Linear Program) is to maximize earings where earnings (E) are the revenues (R) for the transportation of air cargo minus the costs (DOC + IOC):

$$E = R - (DOC + IOC)$$

The earnings are maximized subject to constraints that are typical of airline operations, for example, the number of flights of each type of aircraft into and out of each city must be balanced. Also, the cargo flow cannot exceed the payload or cube capability offered. Other constraints involve the frequency-demand function and the capacity-demand function. In effect these functions operate to regulate the demand. That is, for each route there is a certain maximum magnitude of demand in tons. The linear program must balance the frequency of service offered and the aircraft capacity offered against the specified frequency and capacity curves for each route. For example, if the demand between two points is 100 tons (90 metric tons) and the specified frequency function requires frequency of service of two or more, the LP must allocate frequency of service so that the total frequency offered on the route is equal to two or more, or the demand value of 100 tons (90 metric tons) will, in effect, not be generated. If all other constraints in the program are satisfied and the frequency for this particular route is only one, the total demand for the route would be limited to less than 100 tons (90 metric tons), with the exact value depending upon the frequency-demand curve input; if a straight line segment from 0 to 2 is input, the value for a frequency of one will be 50 tons (45 metric tons). The capacity-demand function constrains the LP in a similar manner. Finally, the two demand functions, frequency and capacity, are combined to determine the value actually used in the solution.

Scenario - Certain operating concepts for the 1990 air cargo system were given by NASA in the work statement; others were developed by Lockheed in the 1990 Transportation Scenario (Appendix I-D), and are the basis for the scenario used in this study to analyze a typical air cargo operation. Specific details of the scenario elements are described in the following paragraphs. The values of the parameters of this typical operation will be the input for the optimization program described in the previous paragraph.

The elements of the scenario are shown in Figure V-2. In the following paragraphs, each element is described, and the values or spectrum of values necessary for the analysis of airline operator profitability in relation to air cargo volume are specified for input into the linear program.

The magnitude of the air cargo demand, Figure V-2, for the domestic and international route system described later is varied between the 1990 lower boundary and the 1990 upper boundary in steps. The demand-frequency function employed is a one-segment straight-line function varied from 1 to n as shown in Figure V-3, where D_T equals the total available demand for the route. The specified frequency, 1 to n, is the minimum that is required for the demand D_T. The frequency constraint is stated as: "greater than or equal to n,";

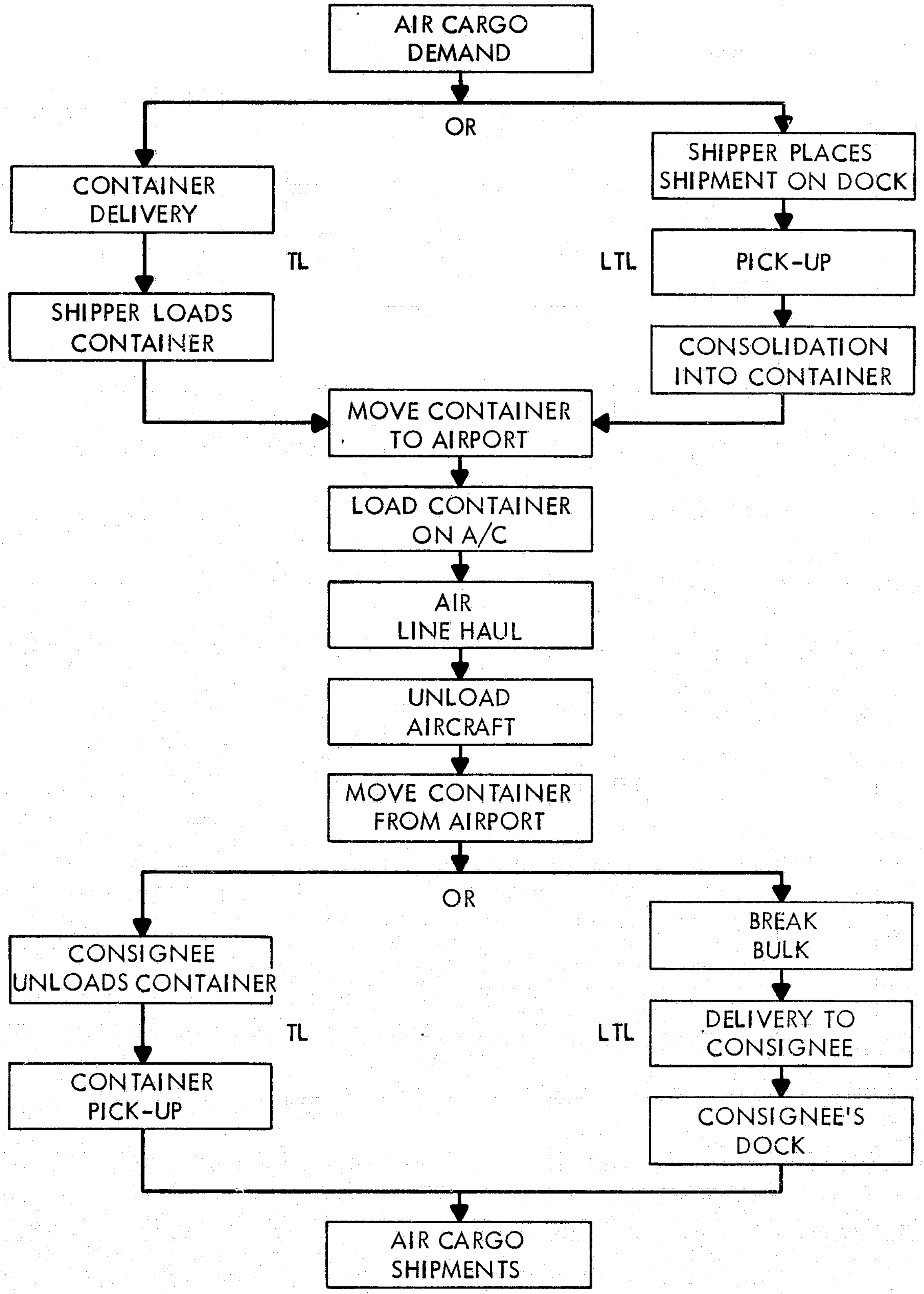


FIGURE V-2. AIR CARGO SCENARIO ELEMENTS

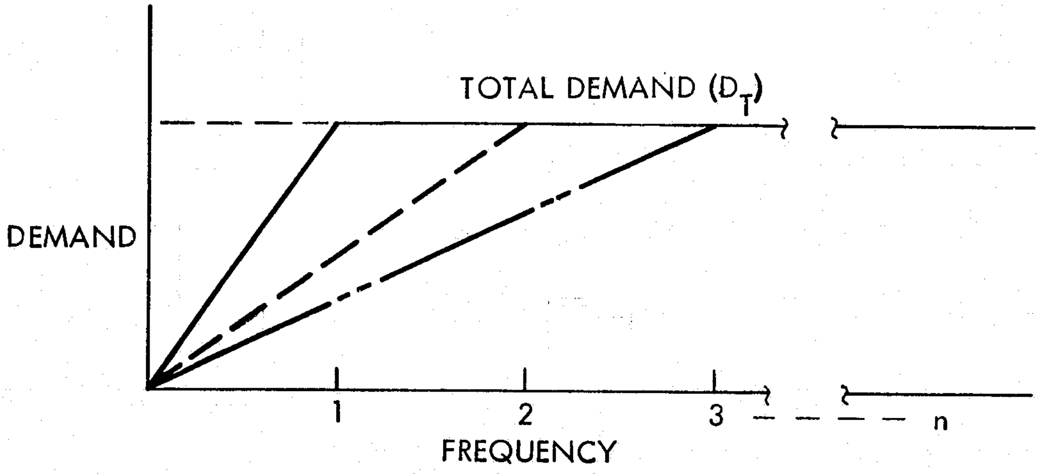


FIGURE V-3. DEMAND - FREQUENCY FUNCTION

therefore, the actual frequency must equal n to cause D_T but may be higher as necessary to develop maximum earnings. Lesser frequencies may be selected, but they cause lesser demand.

The use of this linear demand-frequency function results in a fixed maximum demand that is present whenever the frequency requirement is met. Thus, total demand on each route segment is not a function of frequency. That is, increased frequency above the requirement will not increase the demand. The actual frequency may be reduced below the frequency requirement by other constraints in the linear program. For example, if the number of aircraft into and out of all terminal points (cities) cannot be balanced (equal) with the frequency on all segments equal to the requirement, the linear program will balance the aircraft into and out of the terminal points with the frequency on the least profitable route segment less than the requirement. If the frequency on a route segment is less than the requirement, the demand will be less than D_T and the solution will not have as much cargo as it would have if all frequency requirements were met. The choice of the linear frequency-demand function was made because the analysis of cargo airline systems in this instance is fundamentally involved with only the technical aspects of cargo airline operations, not the competitive supply-demand relations. Thus, in this context, demand is an exogenous variable whose purpose is to provide a range of operating levels for a typical airline from which technical data such as optimum fleet mix, flight hours, and load factors may be obtained. The operating level, that is, total tons of cargo carried per day of the solution, is the variable for which the technical information is pertinent. The fact that the operating level of the solution may be less than the maximum possible tons per day available under other sets of conditions is not an issue in the analysis.

Referring to the scenario shown in Figure V-2, alternatives for both truck-load lots (TL) and less-than-truck-load lots (LTL) are included at the origin and the destination. In the TL case, containers are moved directly to the airport. LTL shipments require consolidation. They are placed on dock by the shipper, picked-up and consolidated into containers which are then moved to the airport. Reciprocal activities on the delivery and complete the door-to-door service covered by the scenario. The cost of consolidation and break bulk in LTL operations is included in the indirect operating cost (IOC).

Various ways of analyzing these costs are covered completely in subsequent paragraphs, which analyze the effect of changes in IOC. In the LP solutions generated for this section, the analysis of expanded air cargo volume on airline operator profitability, the IOC for specific aircraft are varied only between the extremes of LTL and TL operations. As the volume of air cargo operations is increased, it is probable that a greater portion of the cargo will be TL; hence, the profitability effects of TL must be included in the analysis.

The cost of pick-up delivery are calculated separately. In the LP, pick-up and delivery costs would be added to both costs and revenue and they would cancel out in the solution; hence, they are not included in the input data.

Continuing the review of the scenario (Figure V-2) at the airport, containers are loaded on the aircraft and unloaded at the delivery end with no need for additional processing. The cost of this function is also included in IOC. The remaining function in the scenario is the airline haul. The cost of this function is the DOC and a portion of the IOC.

The scenario includes door-to-door operations; that is, the movement of the shipments from the shipping dock at the origin, normally referred to as the shipper's dock, to the receiving dock at the destination, also known as the consignee's dock, is included in the scenario.

This scenario will be the framework for the comparison of freight rates which is included in subsequent paragraphs. Two types of comparisons are necessary. One is airport-to-airport which is used when only the airline operator profitability is being analyzed. The other type of comparison is door-to-door comparison. In this type of comparison, all the functions shown in the scenario in Figure V-2 are included. Conventional air cargo tariffs include only airport to airport transportation. To relate this to door-to-door service requires that the cost of transporting the shipments to and from the airport be added to the air tariffs. This can be a source of confusion because there are many alternative means of transporting the shipments to and from the airport; private carriage, professional pick-up and delivery service, air freight forwarders, contract carriage, and truck rental are commonly used alternatives. The movement at the origin may be accomplished by a different method than at the destination, which adds another variable. The real costs of all the alternatives may be reasonably equal, but the out-of-pocket costs vary over a wide spectrum, and different users have different gages for making choices between the alternatives. Air Cargo Incorporated (ACI) is a professional air cargo pick-up and delivery (PU&D) service. It is owned by the U.S. scheduled airlines and performs PU&D for the airlines in over 450 cities. The ACI Directory lists the cost of PU&D in the cities served by ACI. In this analysis, ACI costs are used for PU&D services. The simple average of the ACI PU&D costs in the top 20 cities is used. Table V-2 lists ACI's PU&D charges for five weight groups.

Another function in the scenario (Figure V-2) is the consolidation of LTL shipments at the origin and the reverse process, called break-bulk, at the destination. Like PU&D, there are several alternative methods for accomplishing this function, and each method may have a characteristic cost. In the 1990 scenario, it is accomplished off the airport. In conventional air cargo operation, it is accomplished at the airport, and the cost is included in the indirect operating cost (IOC). Therefore, in the intermodal scenario, it is necessary to adjust the IOC either by including this off airport operation or by deleting the cost of consolidation - break bulk from the IOC. Both techniques are applicable, depending on the specific set of variables under analysis. For this analysis, the specific technique used in each case will be explained.

TABLE V-2. ACI PU&D CHARGES

City	Minimum Charge $	100 lb (145 kg) $/100 lb ($145 kg)	1000 lb (450 kg) $/100 lb ($145 kg)	2000 lb (900 kg) $/100 lb ($145 kg)	5000 lb (2250 kg) $/100 lb ($145 kg)
Chicago	7.35	3.70	2.90	2.10	1.50
NYC (JFK)	9.70	7.20	5.25	5.00	3.35
Los Angeles	6.50	3.15	2.65	2.20	1.40
San Francisco	7.80	3.95	3.70	3.45	1.85
Atlanta	4.35	1.80	1.65	1.55	1.30
Miami	5.40	2.40	2.20	2.10	1.70
Detroit	6.60	2.60	2.40	2.20	1.70
Seattle	5.70	3.00	2.75	2.55	1.85
Boston	6.55	2.95	2.80	2.70	2.05
Dallas	5.30	2.25	1.95	1.85	1.50
Honolulu	3.95	1.75	1.50	1.40	.85
Philadelphia	6.85	2.75	2.60	2.50	1.90
Newark	7.10	3.60	3.40	3.15	2.30
Denver	5.00	2.65	2.50	2.40	1.85
Minneapolis	5.65	2.40	2.20	2.05	1.55
Cleveland	6.65	3.55	3.15	2.75	1.95
Houston	5.00	1.95	1.75	1.65	1.40
San Juan P.R.	5.00	2.15	2.00	1.90	1.60
Laguandia	9.70	7.20	5.25	5.00	3.35
St. Louis	6.60	3.00	2.50	2.10	1.25
Sample Avg.	6.35	3.35	2.90	2.50	1.80

Parametric System Sensitivity Analysis

Table V-3 presents the parametric variations selected to analyze those relationships, which are discussed in detail below.

Effect of Expanded Air Cargo Volume on Airline Operator Profitability - Airline operator profitability is subject to significant variation in the short term because of economic conditions, traffic variations, transportation strikes, and other factors. Only the transient profitability/volume relationships are revealed in these variations. Long-term trends caused by changes in equipment, rates, route structure, etc. cloud the profitability/volume picture from cause and effect determinations. Thus, it is clear that measures of past performance in both the short term and the long term are inadequate to determine the relationship between expanded air cargo volume and airline operators' profitability. Although currently some relaxation is being experienced, historically, the industry operated in a regulatory environment. Therefore, it is more appropriate to base the analysis on the possible results defined by specific conditions and events rather than to attempt to analyze the significance of past events. In this context, the airline operators' potential profitability, given specific sets of conditions, based on the projected 1990 environment, will be determined in this analysis. The uncertainties present make it necessary to present the results as trends and sensitivities over a range of values or between boundaries.

Airline Operators' Profitability Volume Relationships - This portion of the analysis investigates airline operators' potential profitability in relation to expanded air cargo volume projected for 1990 given specific sets of conditions. For the first set of conditions, there is a single type of cargo aircraft serving a given route system whose demand increases from the lower 1990 boundary to the upper boundary. The elements involved in this case are shown in Figure V-4. The fundamental relationship between earnings (profitability) and volume is established by this set of conditions. Only one parameter, air cargo volume, is varied, and feedback is not considered in this situation. Subsequent to this case, more variables will be included in the analysis.

The 1990 demand spectrum described in Table V-4E is used. Computer runs were made at six points; the 1990 minimum, the 1990 maximum, and increments of 0.2 of the difference between the minimum and the maximum.

The aircraft employed is designated D-70. It is a high-technology, 71,000-pounds (3200-kg) payload aircraft having a gross weight of 242,640 (110,000-kg). This is one of the family of aircraft used in this analysis as shown in Table V-1. Air cargo rates are based on the 1977 tariffs for general commodities. The values for each route segment are derived from the linear regression equations. The domestic route system previously described is used.

TABLE V-3
PARAMETRIC VARIATIONS

	Demand D_T			Aircraft					
	Increment	Tons Per Day	Metric Tons Per Day	Number	Type	Air Cargo Rates	Minimum Service Frequency	DOC	IOC Level *
Volume – Profitability									
Figure 7	6	570 to 10,275	513 to 9248	1	D-70	1977 Domestic	F=1	1977 Costs	#1 Domestic
Figure 8	"	"	"	"	"	"	"	"	"
Figure 9	"	"	"	4	"	"	"	"	"
Figure 10	"	"	"	"	D-70, D-125, D-220, D-330	"	"	"	"
Figure 11	"	"	"	"	"	"	"	"	"
Figure 13	"	"	"	"	"	1977, -15%, -30%, -45%	"	"	"
Rate Sensitive Demand Figure 15	"	"	"	"	"	"	"	"	"
Service Sensitive Demand Figure 16	"	"	"	"	"	1977 Domestic	F=1, F=5 & F = Function of Demand Distribution	"	"
DOC Effects									
Figure 19	"	"	"	"	"	"	F=1	Fuel cost + 50% and + 100%	"
Figure 20	"	"	"	1	D-70	"	"		"
Figure 21	"	"	"	"	D-330	"	"	"	"
IOC Effects Figure 23	"	"	"	4	D-70, D-125, D-220, D-330	"	"	1977 Costs	1,2,3
Combined Effects			4287						
Figure 24	1	4763	"	1	D-220 or L-1	"	"	"	"
Figure 25	"	"	"	"	"	"	"	"	"
Figure 26	"	"		"	"	"	"	"	"
International Demand Figure 29	5	1262 to 3701	1136 to 3331	3	I-125, I-220, I-330	1977 International			#1 Internation

* IOC Levels
1 = Conventional Large Shipment
2 = Conventional Average Shipment
3 = International Large Shipment

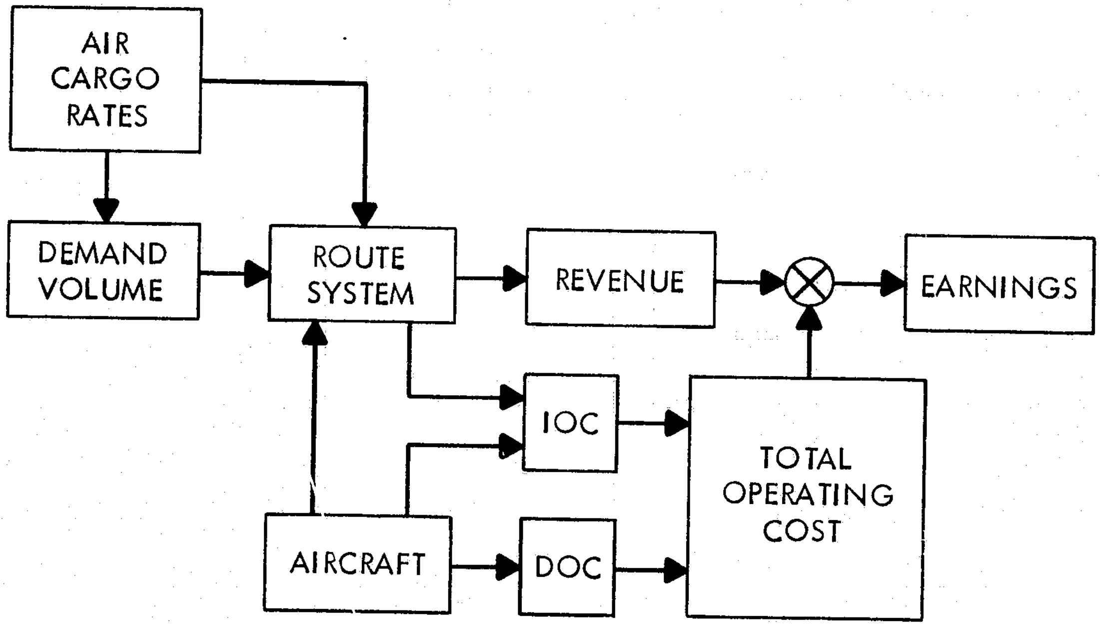


FIGURE V-4. FUNDAMENTAL DEMAND - EARNINGS RELATIONSHIP

TABLE V-4E. 1990 AIR CARGO DEMAND

	Regions	Distance Miles	Demand Tons Per Day						
			MA	MI	Δ	+.2Δ	+.4Δ	+.6Δ	+.8Δ
1	NYC - LAX	2475	392	22	370	96	170	244	318
2	LAX - NYC	2475	1343	74	1269	328	582	835	1089
3	NYC - SFO	2578	289	16	273	71	125	180	234
4	SFO - NYC	2578	973	54	919	238	421	605	789
5	SFO - CHI	1847	188	10	178	46	81	117	152
6	DTT - LAX	1979	200	11	189	49	87	125	162
7	LAX - DTT	1979	263	15	248	64	114	164	213
8	IAH - CHI	925	147	8	139	36	64	91	119
9	CHI - IAH	925	313	17	296	76	136	195	254
10	SFO - DTT	2079	123	7	116	30	53	77	100
11	DTT - NYC	509	646	36	610	158	280	402	524
12	NYC - CHI	740	497	28	469	122	216	310	403
13	CHI - NYC	740	1930	107	1823	472	836	1200	1565
14	CHI - LAX	1745	279	15	264	68	121	173	226
15	LAX - CHI	1745	677	38	639	165	293	421	549
16	NYC - DTT	509	448	25	423	110	194	279	365
17	DTT - SFO	2079	467	26	441	114	202	290	378
18	LAX - IAH	1397	164	9	155	40	71	102	133
19	IAH - NYC	1417	440	24	416	107	191	274	357
20	NYC - IAH	1417	282	16	266	69	122	175	229
21	IAH - LAX	1397	214	12	202	52	93	134	174
			10,275	570	9705	2511	4452	6393	8333

TABLE V-4M. 1990 AIR CARGO DEMAND

	Regions	Distance Km	Demand Metric Tons Per Day						
			MA	MI	Δ	$+.2\Delta$	$+.4\Delta$	$+.6\Delta$	$+.8\Delta$
1	NYC - LAX	3960	353	20	333	87	153	220	286
2	LAX - NYC	3960	1209	67	1142	295	524	752	980
3	NYC - SFO	4125	260	14	246	63	112	162	211
4	SFO - NYC	4125	876	49	827	213	379	544	710
5	SFO - CHI	3000	169	9	160	41	73	105	137
6	DTT - LAX	3166	180	10	170	44	78	112	146
7	LAX - DTT	3166	237	14	223	59	103	148	192
8	IAH - CHI	1480	132	7	125	32	57	82	107
9	CHI- IAH	1480	282	15	267	68	122	175	229
10	SFO - DTT	3326	111	6	105	27	48	69	90
11	DTT - NYC	814	581	32	549	142	252	361	471
12	NYC - CHI	1184	447	25	422	107	194	278	363
13	CHI - NYC	1184	1737	46	1691	384	722	1061	1399
14	CHI - LAX	2792	251	14	237	61	109	156	204
15	LAX - CHI	2792	609	34	575	149	264	379	494
16	NYC - DTT	814	403	23	380	99	175	251	327
17	DTT - SFO	3326	420	23	397	102	182	261	340
18	LAX - IAH	2235	148	8	140	36	64	92	120
19	IAH - NYC	2267	396	22	374	97	172	246	321
20	NYC - IAH	2267	254	14	240	62	110	158	206
21	IAH - LAX	2235	193	11	182	47	84	120	157
			9248	513	7861	2260	4006	5753	7500

The linear program output includes total revenue, R_T, obtained from transporting the cargo, total cost C_T, and total earnings, E_T. The values of these are shown in Figure V-5 as a function of air cargo volume.

The average load factor obtained in these operations is shown in Figure V-6. When demand is low, most routes are served with a frequency of service of one. That is, if one aircraft is allocated to most route segments, it will satisfy the demand when the demand is low. Even so, many aircraft will not be loaded to capacity. The resultant load factor reflects this condition. As demand increases, the load factor increases and more aircraft must be allocated to the routes, which is an increase in frequency. The average frequency for the routes when the total volume is 500 tons (450 metric tons) per day is 1.38. Obviously, route segments with greater demand will require greater frequency of service when there is only one size of aircraft offered. A total demand for this route network is increased, at 7,350 tons (6,670 metric tons) per day, the average frequency of service is 9.8. The route with the highest demand, Chicago-New York City, requires a frequency of 28.6 when the total carried on the network is 7,350 tons (6,670 metric tons) per day. The load factor increases rapidly with demand, Figure V-8, until the situation is reached where demand is high enough so almost all flights are full. The load factor in this case reaches 93 percent.

A measure of airline operator profitability that can be derived from the LP output is earnings per ton, E_T, of cargo transported. The relationship of earnings per ton and air cargo volume is plotted in Figure V-7. Total earnings, E_T (Figure V-5), are almost linear. Earnings per ton (Figure V-7), which are derived from E_T, would be a constant, insensitive to volume, except for the fact that the total earnings curve does not pass through the origin. There is a finite cost of operating the aircraft with no payload, and with no revenue, the total earnings are negative with zero air cargo volume, as shown by the dotted lines in Figure V-5. This situation gives rise to the characteristic shape of the earnings per ton curve, Figure V-7.

No analysis was done below 570 tons (513 metric tons) per day. If this had been done then logically there would have been a very rapid drop in earnings, as shown by the dotted lines in Figure V-7.

Characteristics of Optimization Analysis - One characteristic of this type of analysis is that the value of the output such as earnings and the derivative, earnings per ton, for example, are much higher than would be expected in actual operations. This is because the model operates in an unregulated environment and simply does not fly any route that does not increase overall profit. Additionally, the model does not include many costs or losses of revenue that result from off-optimum operation. For example, the linear program does not reflect the cost of providing the equipment necessary to cope with the day-to-day fluctuation in demand which occurs in reality. The resources allocated to a specific problem in the LP are exactly the amount required to obtain maximum earnings. The cost of operational inefficiencies associated with routing and scheduling are not included in the optimum analyses. In the LP, the number of each type of aircraft into and out of each

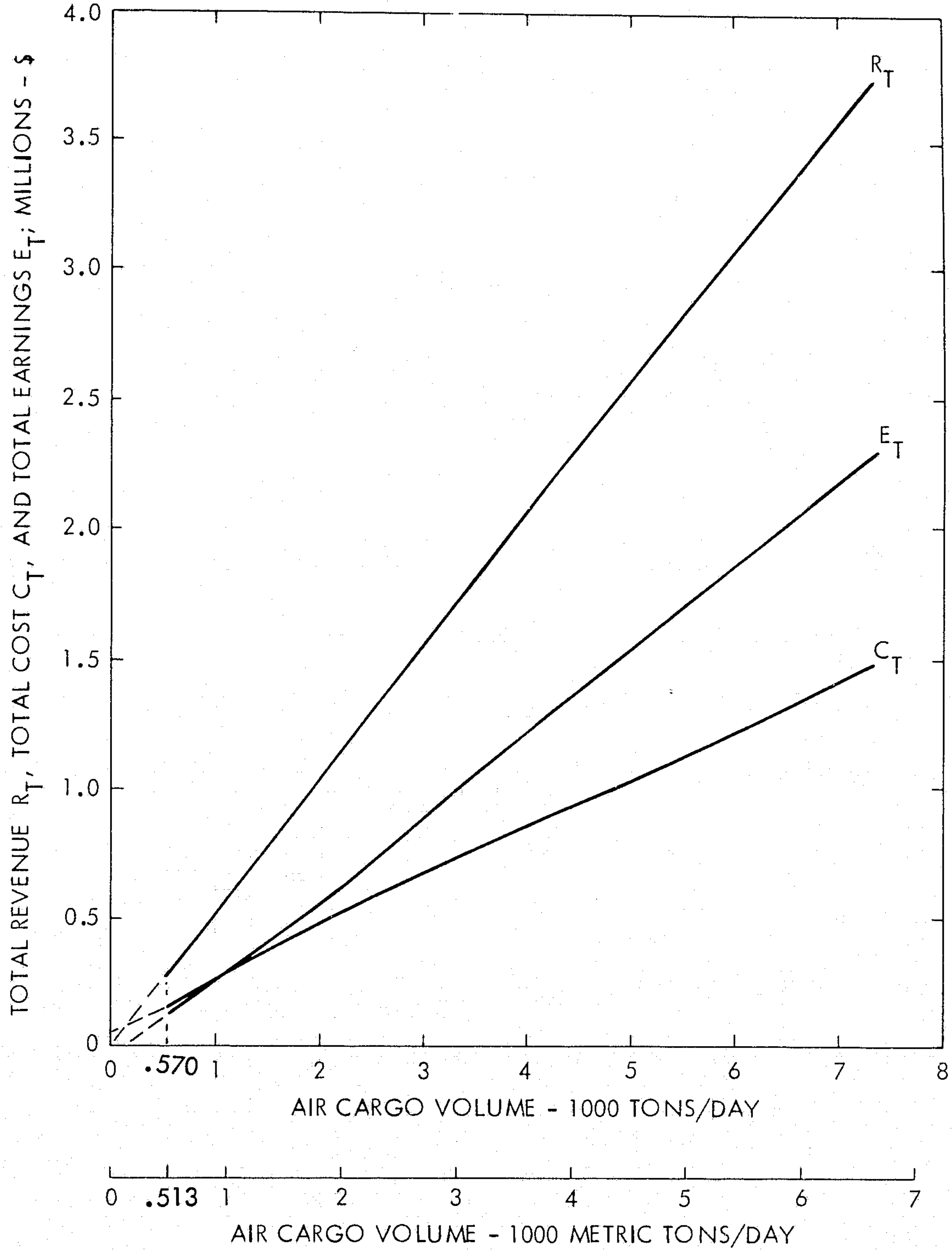


FIGURE V-5 . TOTAL REVENUE, COST AND EARNINGS

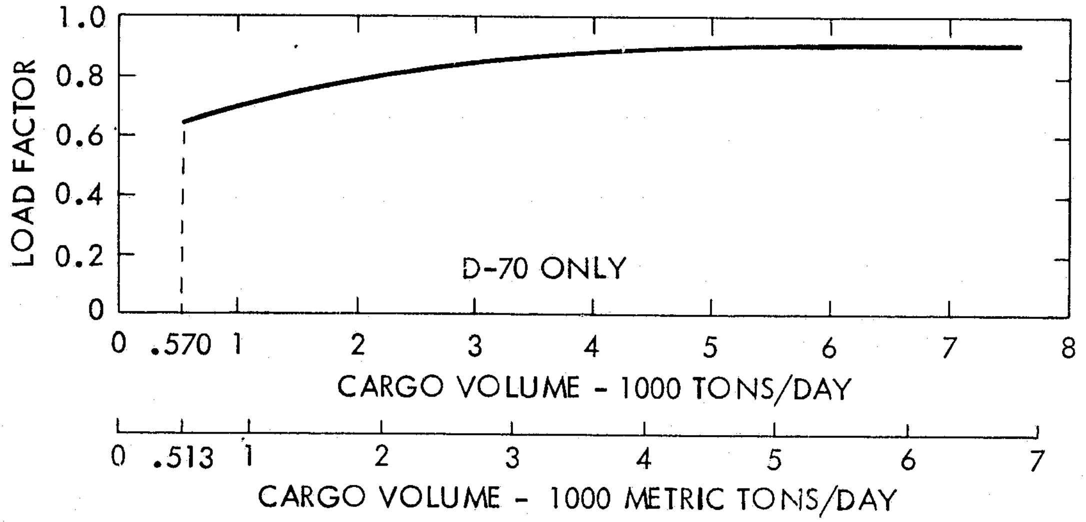


FIGURE V-6. LOAD FACTOR - VOLUME RELATIONSHIP

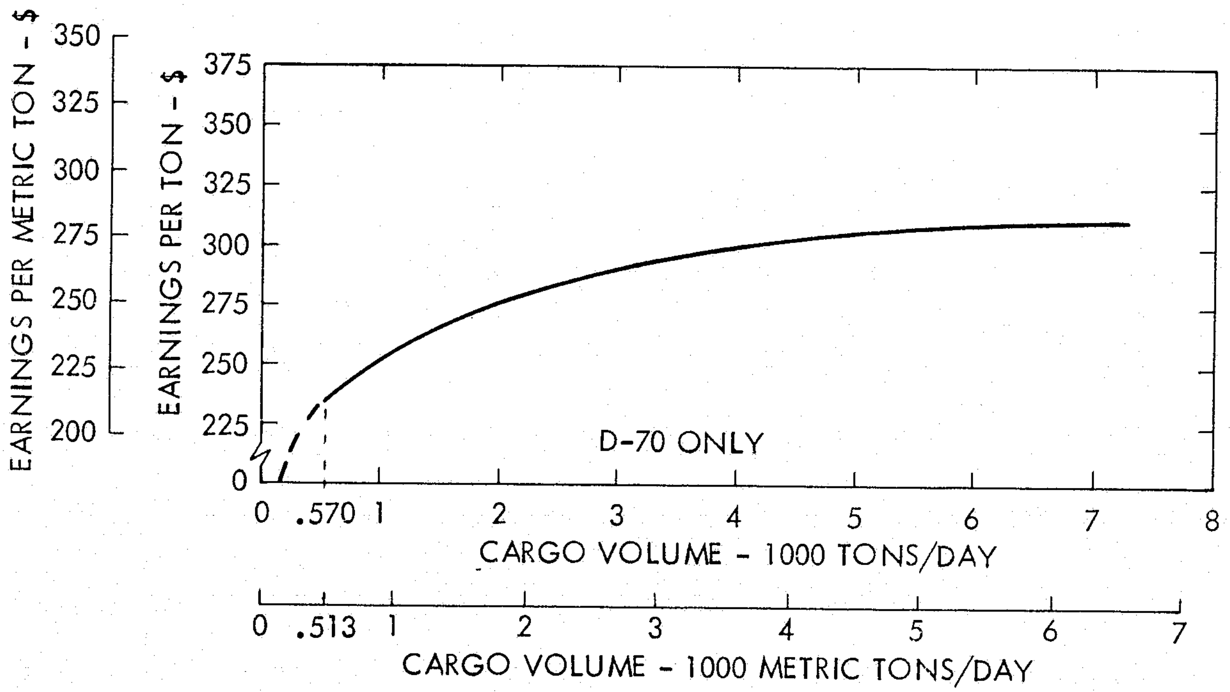


FIGURE V-7. EARNINGS/TON-VOLUME RELATIONSHIP

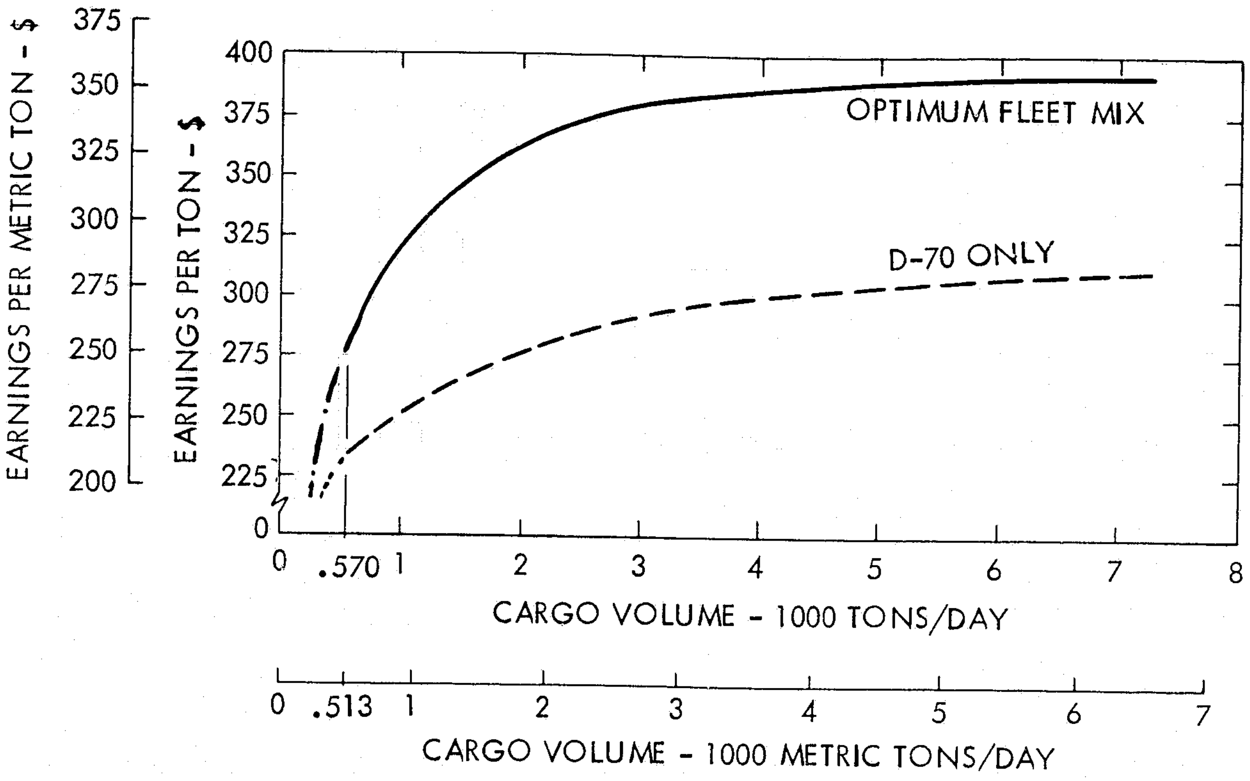


FIGURE V-8. EARNINGS PER TON

city must be balanced; however, aircraft are originated at any city to maximize earnings for each problem. Most airline operators cannot change aircraft basing as demand fluctuates. Another factor that is not treated in the optimum analysis is losses due to reasons such as uncollected charges, special rates, and the cost of promotional activities other than the IOC allocation for advertising and publicity. There are many reasons for not including these and other similar factors to the LP; including off-optimum constraints and limits that can obscure the relationships being investigated, often in a secondary or undefined manner; also credible sources of data for these factors are not available.

The optimization process provides data for preliminary assessment of the relationships that are being investigated. The values obtained from the optimum solutions are the potential available from optimum operations and not those expected from off-optimum, actual conditions. Modifications could be introduced to the optimum analysis to account for real-world inefficiencies but in addition to the increased data processing effort, there would be a danger of misinterpretation of the data. For these reasons, the optimized data directly from the LP will be presented.

Expansion of the Profitability-Volume Relationship - The fundamental relationship revealed in Figure V-7 is now expanded by including additional variables in the solution. In the previous solution, only one size aircraft was applied to the route system. In the following solutions, a spectrum of aircraft sizes will be offered and the LP will find the mix that provides maximum earnings. The four aircraft that have characteristics described in Table V-1 are substituted into the "aircraft" block of Figure V-4.

The results of a series of LP runs with these four aircraft are shown in the following figures. It is noted that the earnings per ton (Figure V-8 solid line) is higher when the optimum fleet mix is selected than in the previous case example when only one size of aircraft was used, the D-70 (Figure V-8 dashed line). Here again, no analyses were accomplished below 570 tons (513 Metric tons) per day. A point check indicated that logically the results would be as shown by the dotted lines below 570 tons (513 metric tons) per day. The optimum fleet mix curve in Figure 10 shows the results of being able to select the best combination of aircraft for best earnings as the market share grows.

The Importance of Rates and Service on AACS Requirements - The aircraft requirements most affected by rates and service is the payload. The payload affects the frequency-demand relationship and the price-demand function. The frequency-demand relationship and price-elasticity of demand are interdependent. For a given total demand, however, the two functions have opposite effects on aircraft payload requirements. Demand segments that are sensitive to frequency of service establishe requirements for greater numbers of smaller payload aircraft. Demand segments that are sensitive to reduce freight rates emphasize the requirements for fewer, more economical, larger payload aircraft. A compromise must be reached where the breakeven load factor is low enough to permit reasonable frequency of service but large enough to allow the rates to take advantage of the price-elasticity of demand.

Such a compromise is made more difficult by the fact that the volume of demand on each route segment is different. In the following analysis, the relationship of each type of demand to aircraft requirements will be presented separately. The integration of both effects will be discussed in later subsections.

Effect of Rate Changes on Earnings/Volume Relationships - The fundamental airline operator's profitability/volume interdependency discussed in the previous section was based on current (1977) air cargo rates. This subsection will address the importance of rate changes on the market and the effects on profitability and growth or volume of demand. Referring to Figure V-4, the "air cargo rates" block shows two outputs. One denotes that rates have an effect on demand; presumably, the price-elasticity of demand will cause the demand to change as a function of rates. The other output, which feeds the route system, affects revenue. Assuming that air cargo demand is independent of rates, as shown in the simplified diagram of Figure V-9, three series of computer runs were made with the rates changed in discrete steps: 15 percent, 30 percent, and 45 percent below the 1977 level. The results of these runs are shown in Figure V-10.

Analysis of Rate-Sensitive Demand - The simplistic diagram of the air cargo analysis (Figure V-1) does not describe the higher-order interdependencies involved in the more complex relationships to be investigated in connection with demand sensitivity to rates and service. In Figure V-11, the details of the demand function are included. The air cargo demand based on the forecast for 1990 is applied to a typical route system as previously described. Each segment in the route system is operated on by the three inter-related demand functions: magnitude, frequency, and capacity. These requirements are reconciled by the linear program. Air cargo rates were varied independently of demand in the previous analysis of the fundamental relationship between rate changes and airline operators' potential profitability. In this analysis, the more complex relationship involving demand and earnings in relation to changes in rates will be investigated. Thus, referring to Figure V-11, earnings has a first-order interdependency on rates through the LP and higher orders of interdependency through the demand functions and the LP. Most computer runs are made in series, where only one variable is changed through its entire feasible or selected range. Therefore, this analysis is based on selecting specific runs from different series to acquire the desired data. This brings up the problem of developing the proper basis for selecting the data runs. Price-elasticity of demand is the primary economic indicator that is the basis used in this analysis.

Price Elasticity of Demand - The price elasticity of demand, which is the percentage change in the quantity of air cargo demanded divided by the percentage change in the price or rates, can be developed from Figure III-12 in Section III. Table V-5 contains the demand values obtained from the curve in Figure III-12 for yield reductions of 0 percent, -15 percent, -30 percent, and -45 percent from 1977 values. Table V-5 also shows the associated yield reduction starting from a current (1977) value of 30 cents per ton/mile (21

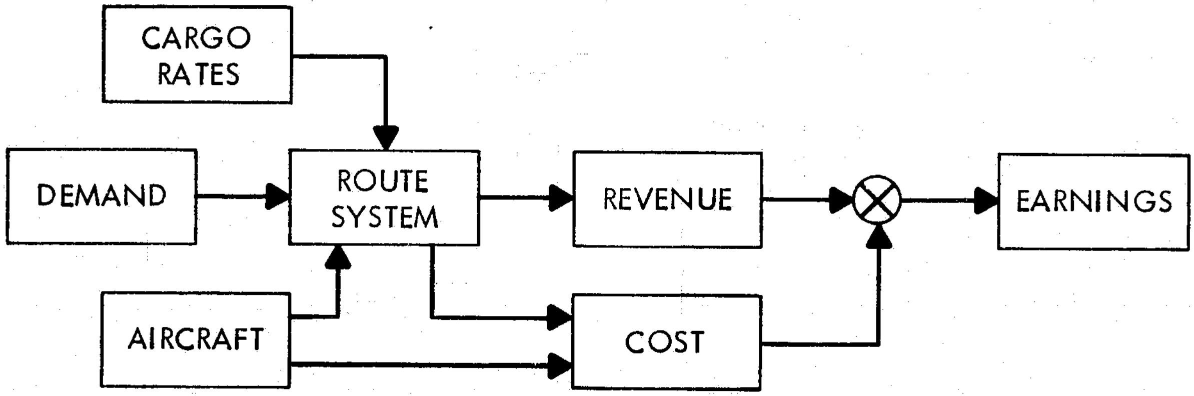


FIGURE V-9. AIR CARGO DEMAND INDEPENDENT OF RATES

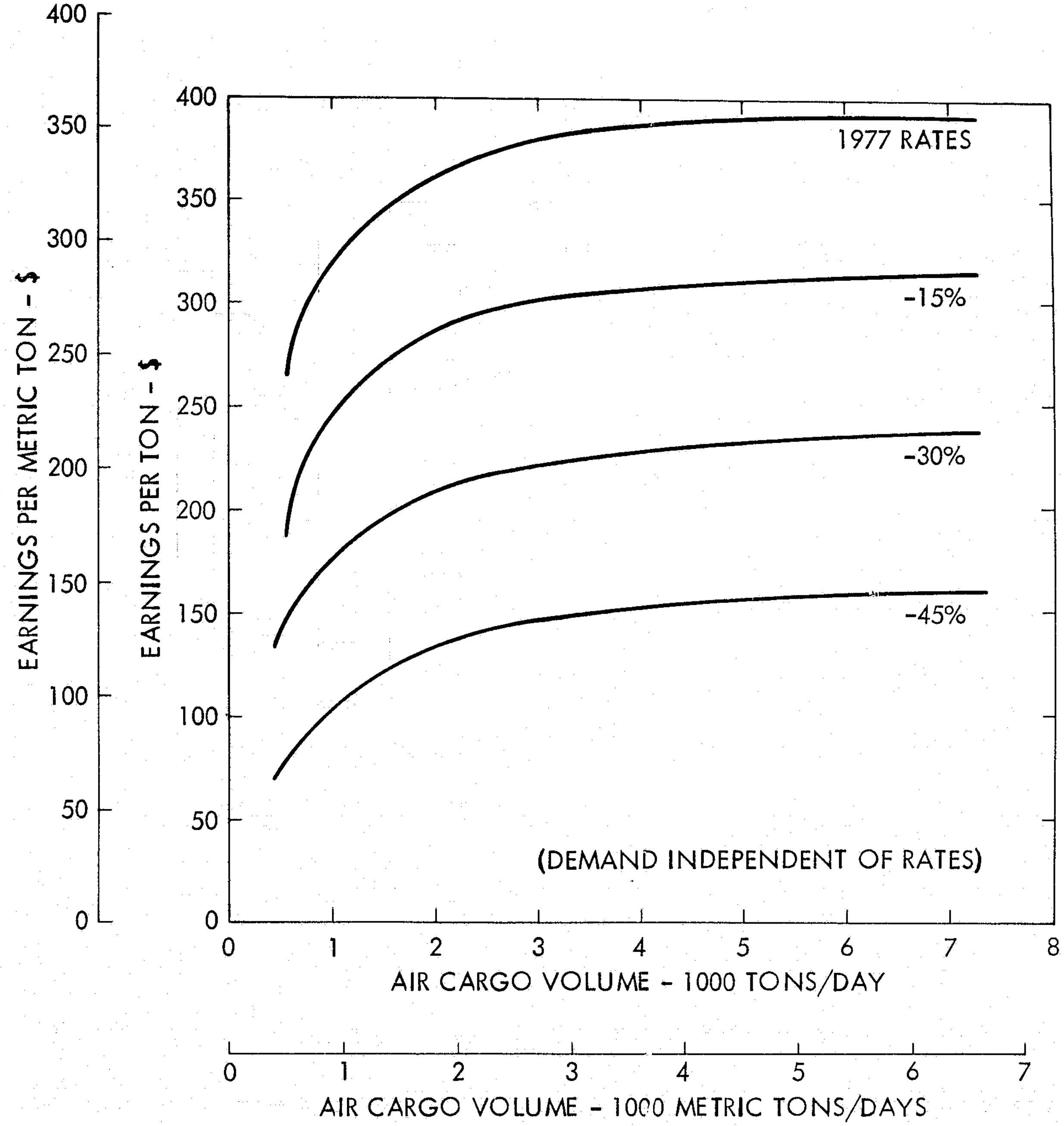


FIGURE V-10. EARNINGS/TON - VOLUME

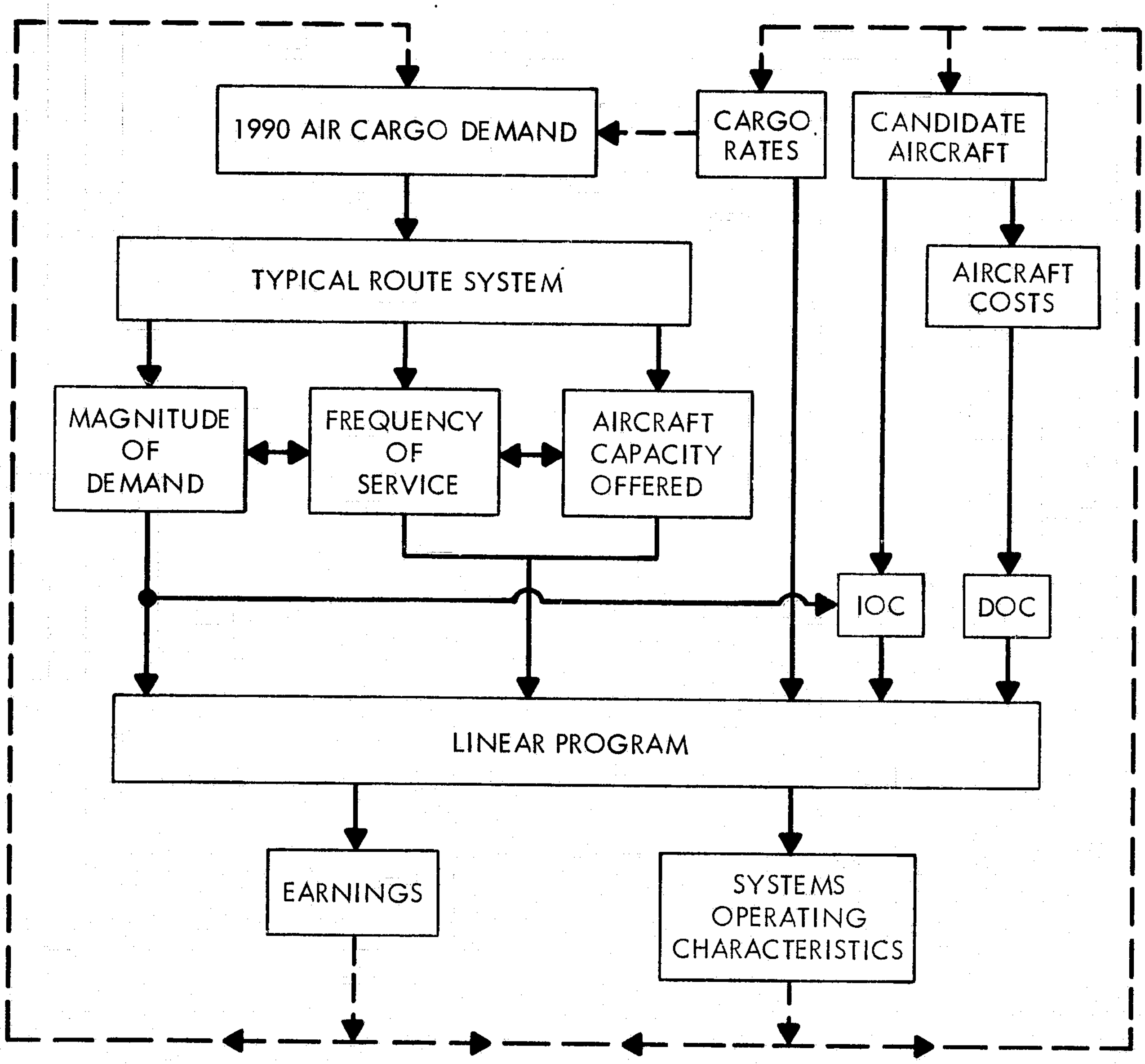


FIGURE V-11. AIR CARGO ANALYSIS SYSTEM INCLUDING DEMAND FUNCTION DETAILS

TABLE V-5. PRICE-DEMAND VALUES

	PRICE (YIELD)		DEMAND		
REDUCTION IN YIELD	¢/TON-MILE	¢/METRIC TON-KM	MILLIONS OF TONS	MILLIONS OF METRIC TONS	PRICE DEMAND ELASTICITY
0 (1977 YIELD)	30	21	1.2	1.1	
-15%	26	18	1.9	1.7	2.8
-30%	21	15	3.6	3.2	3.2
-45%	17	11	8.0	7.2	3.2

cents per metric ton/kilometer), although any other value will provide the same results in the elasticity calculations.

The price elasticity of demand is calculated by the following equations; for example, between any two points (P_1) and (P_2) the price elasticity E is:

$$E = \frac{\dfrac{X_2 - X_1}{X_2 + X_1}}{\dfrac{Y_1 - Y_2}{Y_1 + Y_2}}$$

Where X = Demand

Y = Price

Normally, elasticity is characterized into five categories: (1) perfectly elastic, where E = infinity; (2) relatively elastic, E greater than one; (3) unit elasticity, E = 1; (4) relatively inelastic, E = less than 1, and (5) perfectly inelastic, E = 0. This classification system is normally adequate to evaluate the price-demand relationship without reference to or analysis of the specific values of E. From the analysis of Section III and the data of Table V-6, the demand should remain elastic through 1990. With the development of the above price-elasticity of demand selected runs can be made to describe the long-term earnings-rates relationship. Total earnings, E_T, for four series of LP runs are plotted in Figure V-12 as a function of air cargo volume. Each curve is the total potential earnings as air cargo volume is varied. Other parameters are held constant. Each series consists of six runs with the air cargo volume varied as described in Table V-4. The point on each curve in Figure V-12 at which the specific rates are effective is found from data in Table V-5.

The total annual air freight traffic in millions of tons is translated to the daily tons for a representative airline by a factor that includes 250 days per year operation and 7 percent of the total traffic as described in the section on development of the route system for the LP. The daily cargo volume for the representative airline is shown in the right-hand column of Table V-6. The values thus obtained are now identified on the appropriate curves of Figure V-12.

Based on the projected price-demand relationship derived from the Case Studies, airline operator's marginal earnings remain positive with rate reductions up to 45 percent. As shown in Figure V-12, total earnings as a function of air cargo volume, or demand, were obtained from the composite runs

TABLE V-6. REVENUE AND TRAFFIC

	REVENUE		AIR FREIGHT TRAFFIC			
BASIS	VALUE		ANNUAL TOTAL		REPRESENTATIVE AIRLINE	
	¢ PER TSM	¢ PER METRIC TON KM	MILLION TONS	MILLION METRIC TONS	TONS PER DAY	METRIC TONS PER DAY
1977 RATES	30	21	1.2	1.1	324	312
-15%	26	18	1.9	1.7	545	494
-30%	21	15	3.6	3.3	1032	936
-45%	17	11	8.0	7.3	2294	2080

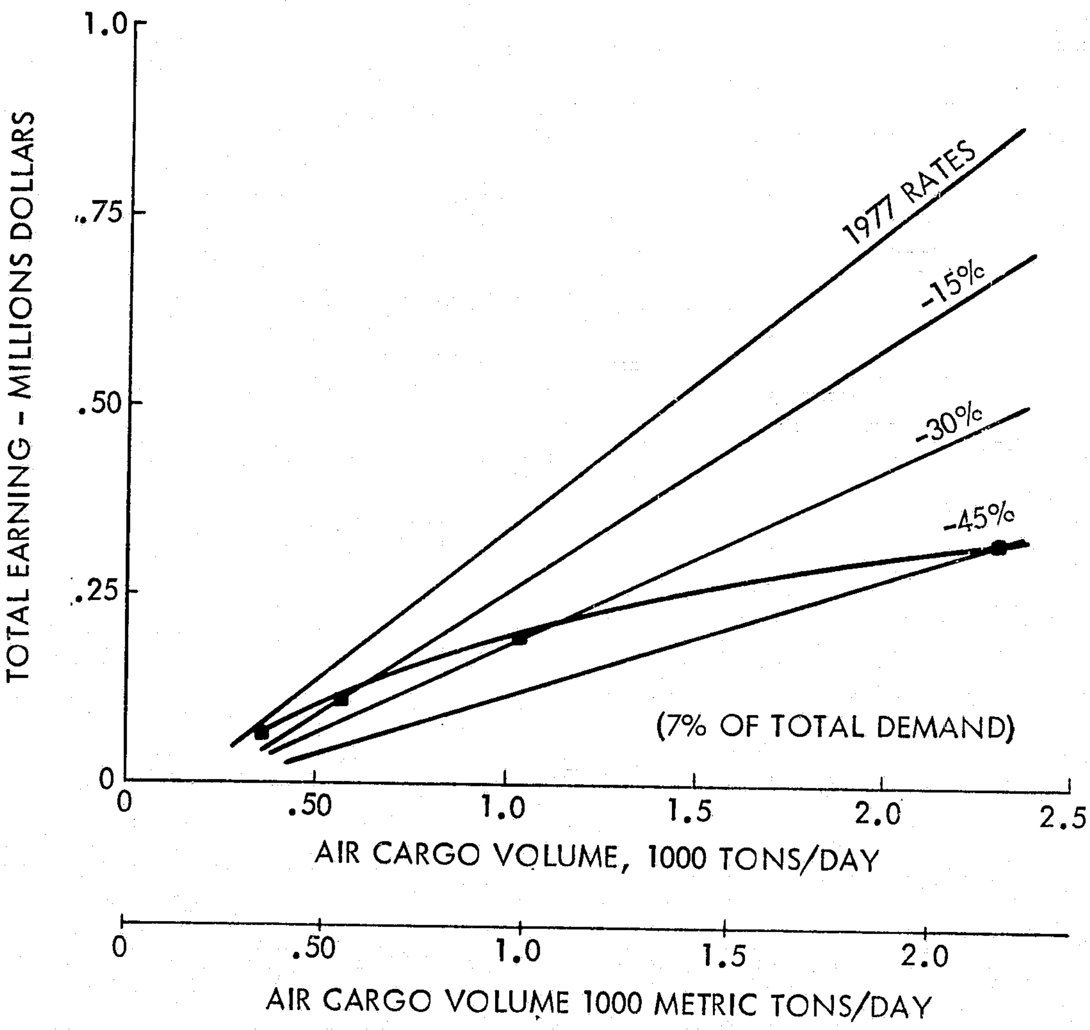


FIGURE V-12. TOTAL EARNINGS REPRESENTATIVE AIRLINE for four sets of conditions: 1977 air cargo rates and three reductions (-15, -30, and -45 percent) shown by the straight lines. On each earnings line the potential volume of cargo corresponding to the price-elasticity of demand is identified. In other words, for each price, 1977 rates, -15, -30, and -45 percent from 1977 rates, there is a specific potential volume of cargo demand. The curve that connects these four points is the airlines total earnings with increasing volume. The slope of this curve is the marginal earnings or marinal profitability, i.e., how much profit was provided by the last ton of cargo. At some point, increased volume will not produce increased earnings; the marginal profitability at that point is zero. Beyond that point, operating cost would have to be reduced to retain positive marginal profitability.

Analysis of Service Sensitive Demand - In the initial description of the air cargo demand, it was noted that there are three separate but interdependent functions: magnitude of demand, frequency of service, and aircraft capacity offered on each route. These three functions are shown in Figure V-11. Actually, only two of the functions are effective in this analysis because the inputs to the capacity function are adjusted so that capacity offered will never be limiting. The frequency function will always be controlling. Therefore, the two active demand functions are magnitude and frequency. For the analysis of frequency effects, air cargo rates will be held constant. In the simple, linear, demand-frequency effects, air cargo rates will be held constant. In the simple, linear, demand-frequency function (Figure V-3), the frequency is the minimum frequency required for the total demand D_T. In the optimized solution, the LP may allocate frequencies greater than one if necessary to maximize earnings.

The results of three series of computer runs with different frequency requirements are shown in Figure V-13. Two series of runs were made with constant frequencies, f = 1 and f = 5, for all route segments, regardless of the magnitude of the demand; one series of runs was made with the frequency requirement on each route segment proportional to the demand. Comparing the two constant frequency runs, the earnings per ton are less for f = 5 than for f = 1, because with a given fixed demand on each route segment, the cost per ton will be higher if the minimum number of trips required for all segments is 5 than if the minimum number of trips is 1. The higher costs will be reflected in lower earnings per ton as shown in Figure V-13. When the frequency requirement on each route segment was made proportional to the magnitude of the demand (Table V-7), the results shown by the dashed line in Figure V-13 were obtained. Comparing this curve with the constant frequency curves, it is noted that, for a given level of operations, the earnings per ton are higher for the proportional frequency requirement than for the constant frequency requirement.

More detailed examination of the solutions for this series of runs reveals that, for this requirement, the more profitable cargo is retained, but cargo of lower profitability is eliminated by the aircraft balancing equations. In real-world airline operations, the function of aircraft balancing is performed in the scheduling operations which must include many additional factors not included in MACRO. Factors in addition to frequency of service, such as,

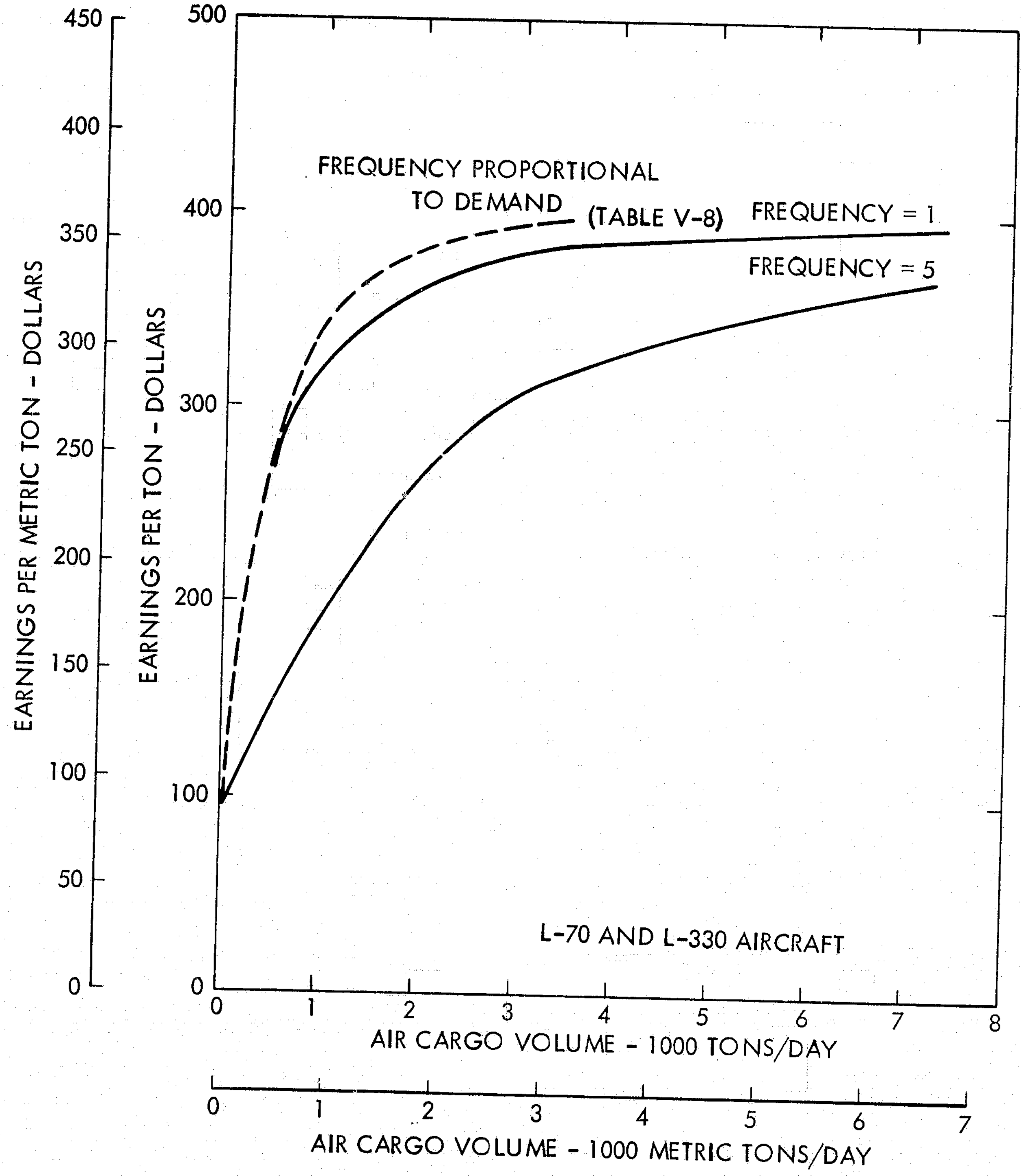


FIGURE V-13. FREQUENCY EFFECT ON EARNINGS

TABLE V-7. FREQUENCY CONSTRAINTS

REGIONS	DEMAND DISTRIBUTION %	FREQUENCY CONSTRAINT F
1. NYC - LAX	3.8	2
2. LAX - NYC	13.1	6
3. NYC - SFO	2.8	2
4. SFO - NYC	9.5	5
5. SFO - CHI	1.8	1
6. DTT - LAX	2.0	1
7. LAX - DTT	2.6	2
8. IAH - CHI	1.4	1
9. CHI - IAH	3.1	2
10. SFO - DTT	1.2	1
11. DTT - NYC	6.3	4
12. NYC - CHI	4.8	3
13. CHI - NYC	18.8	6
14. CHI - LAX	2.7	2
15. LAX - CHI	6.5	4
16. NYC - DTT	4.4	3
17. DTT - SFO	4.5	3
18. LAX - IAH	1.6	1
19. IAH - NYC	4.3	3
20. NYC - IAH	2.7	2
21. IAH - LAX	2.1	2

departure times, bases for aircraft and crews, and maintenance activity must be considered in developing an operating airline schedule.

The indication provided by the series of runs with the proportional frequency requirement, which is more realistic than the constant frequency requirement, is that demand that is sensitive to frequency of service will not have a serious detrimental effect on profitability when combined with the other scheduling requirements.

Effect of Direct and Indirect Operating Cost

The effect of changes in direct operating cost (DOC) and in indirect operating cost (IOC) on airline operator profitability is discussed in the following paragraphs.

Direct Operating Cost - The level of aircraft technology plays an important part in the direct operating cost. This dependency is shown by expanding the air cargo analysis system previously described in Figures V-1 and V-11 to include more details relating to the aircraft. This expansion is shown in Figure V-14. In the following paragraphs, the development of the DOC is discussed, and the effect of changes in DOC on airline operator potential profitability is analyzed.

Direct Operating Cost Calculation - The direct operating cost of the aircraft are calculated by the methodology of ref. 2. All input factors, such as wage rates and fuel cost are based on 1977 costs. The DOC of each aircraft for the route segment in the typical route network are calculated in a computer program. The results of these calculations for the family of domestic aircraft are shown in Figure V-15. Direct operating costs consist of the three categories listed below:

1. Flying operations

    Flight crew costs

    Fuel and oil

    Hull insurance

2. Direct Maintenance - Flight Equipment

    Labor - aircraft and engines

    Material - aircraft and engines

    Maintenance burden

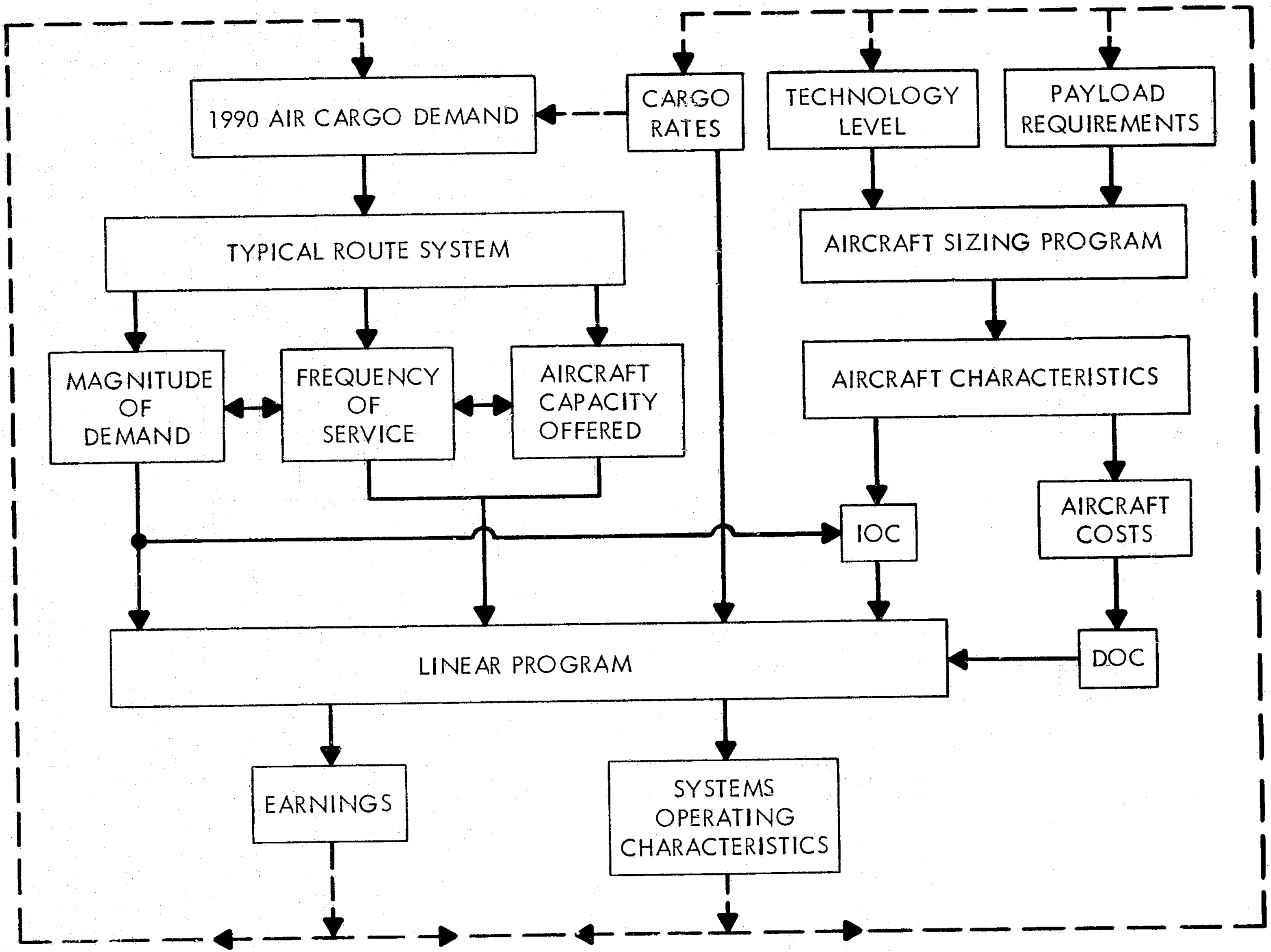


FIGURE V-14. AIR CARGO ANALYSIS SYSTEM INCLUDING DETAILS OF THE AIRCRAFT PROGRAM

C-2

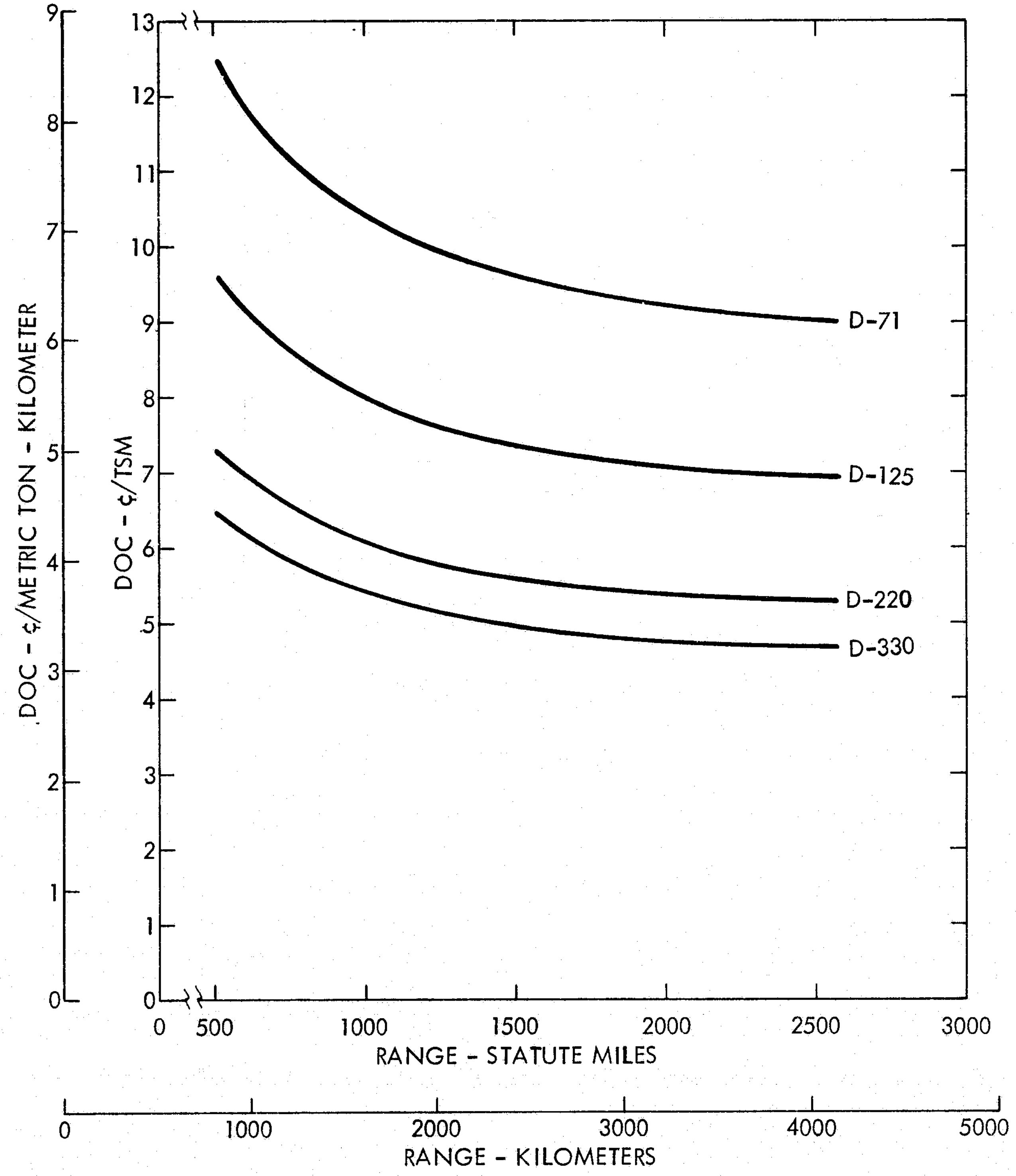


FIGURE V-15. DOMESTIC AIRCRAFT DOC

3. Depreciation - Flight Equipment (Aircraft and Spares)

Airplane cost

Annual utilization

Some of the cost elements are functions of maximum takeoff gross weight, some are functions of the total aircraft cost and some elements such as fuel are related to distance flown. The distribution of the total DOC between the cost elements can be instrumental in more clearly demonstrating the relationship between the cost elements. In Table V-8, the distribution of DOC between the cost elements is shown for short distances, (500 miles/800 kilometers) and for long distances (2500 miles/4000 kilometers). The smallest and largest of the domestic aircraft are included in Table V-8, the D-70, and the D-330. The other domestic aircraft would display distribution of costs between those extremes.

The following example of a change in the price of one of the DOC elements is used to evaluate the sensitivity of operator potential profitability to DOC. The cost of fuel and oil, which constitutes 22 percent to 32 percent of the DOC for the aircraft used in this analysis, was changed for two series of LP runs. In the first series of runs, the cost of fuel was increased 50 percent; in the second series, the cost was doubled. The earnings per ton effect is shown in Figure V-16. A fleet mix of D-70 and D-330 aircrat was used. The relationship of fuel cost to earnings is used to construct boundaries for sensitivity of percent change in earnings per ton to percent change in DOC. Boundaries are necessary rather than a single sensitivity curve because the sensitivity is a function of both route segment distance and volume of demand. After the boundaries are determined, some generalizations can be made on DOC effects. Table V-9 shows the DOC for the D-70 and D-330 aircraft for two route segments. A long distance segment NYC-LAX and a short segment, NYC-CHI. The percentage change in DOC from the 1977 baseline values is also shown in the table.

The data in Table V-10 which were taken from Figure V-16 are combined with the data in Table V-9 to quantify the sensitivity of the profitability-DOC relationship shown in Figure V-17. Figure V-18 shows an identical set of curves for the D-330 aircraft. From these curves, the following generalizations can be made: As the air cargo industry matures and demand increases, profitability tends to be less sensitive to DOC. Potential profitability on the longer route systems, characteristic of the intermodal concept, is less sensitive to changes in DOC than the short route systems. A composite of Figures V-17 and V-18 can be constructed to show that the higher-payload aircraft is less sensitive to changes in DOC than the lower-payload aircraft. The DOC for each aircraft in the high-technology domestic family of aircraft at 2500 miles, from Figure V-15, is shown in Figure V-19. A similar curve of current-technology aircraft DOC's is also shown in Figure V-19. Figure V-19 indicates that advanced technology aircraft provide a 15 to 20 percent reduction in DOC over that of current technology

TABLE V-8. DISTRIBUTION OF DIRECT OPERATING COST

	Short Distance (500 miles/800 Km)	
	L-70 %	L-330 %
Flying Operations	43.2	40.4
Crew	17.6	8.8
Fuel & Oil	22.2	8.8
Hull Insurance	3.4	3.6
Direct Maintenance	30.1	30.4
Depreciation	26.7	29.2
	Long Distance (2500 miles/4000 Km)	
Flying Operations	48.3	45.9
Crew	18.5	9.3
Fuel & Oil	26.3	32.8
Hull Insurance	3.5	3.8
Direct Maintenance	23.6	23.6
Depreciation	28.1	30.5

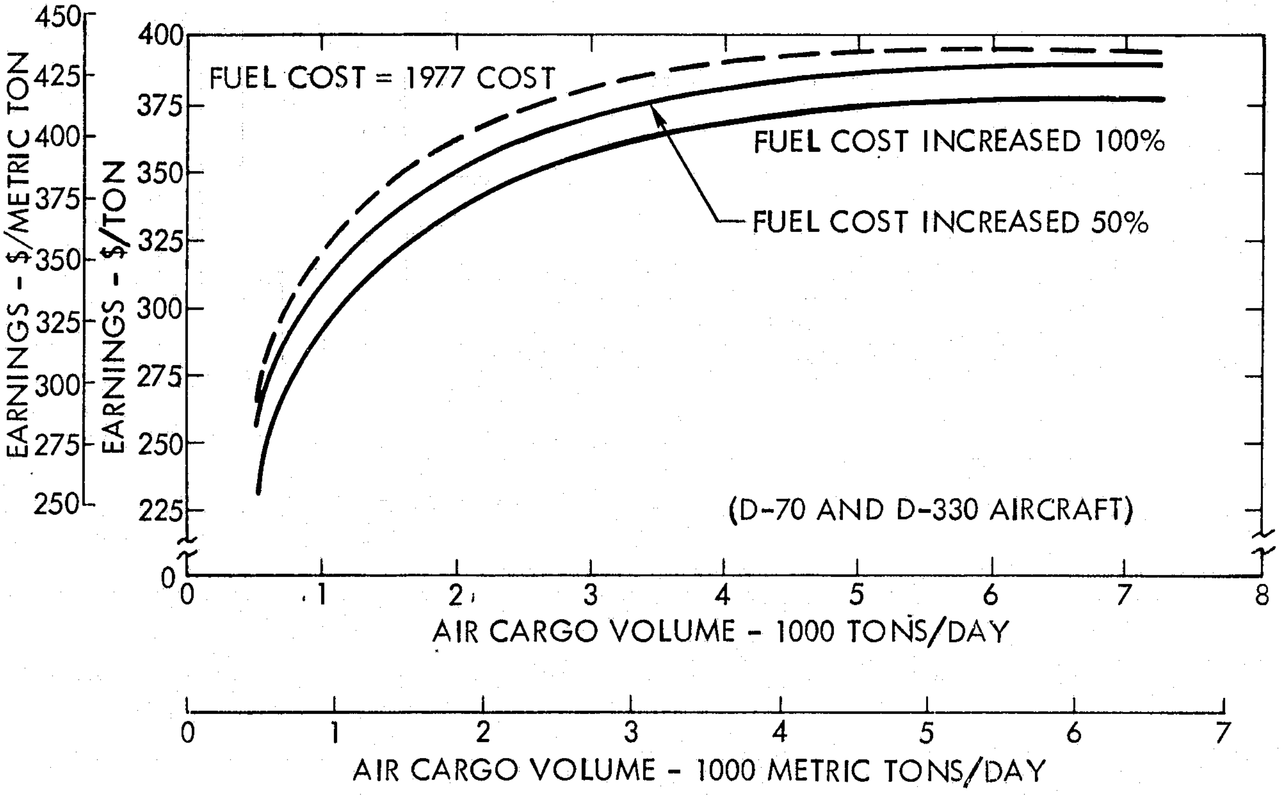


FIGURE V-16. EFFECT OF FUEL COST CHANGES ON EARNINGS PER TON

TABLE V-9. DIRECT OPERATING COST DISTRIBUTION

Route	A/C	DOC 1977 Fuel Cost $	DOC Fuel + 50% $	DOC Increase %	DOC Fuel + 100% $	DOC Increase %
NYC-LAX	D-70	7,959	9,004	13.13	10,049	26.26
	D-330	19,089	22,217	16.39	25,346	32.78
NYC-CHI	D-70	2,929	3,254	11.1	3,579	22.19
	D-330	7,006	7,985	14.0	8,964	27.95

TABLE V-10. PERCENT CHANGE IN EARNINGS PER TON WITH FUEL COST INCREASES

Air Cargo Volume Tons/Day	Metric Tons/Day	Earnings Per Ton 1977 Fuel Cost $	Earnings Per Ton Fuel +50% $	Change %	Earnings Per Ton Fuel +100% $	Change %
550	499	264	256	3.03	230	12.9
7300	6623	393	390	0.76	376	4.33

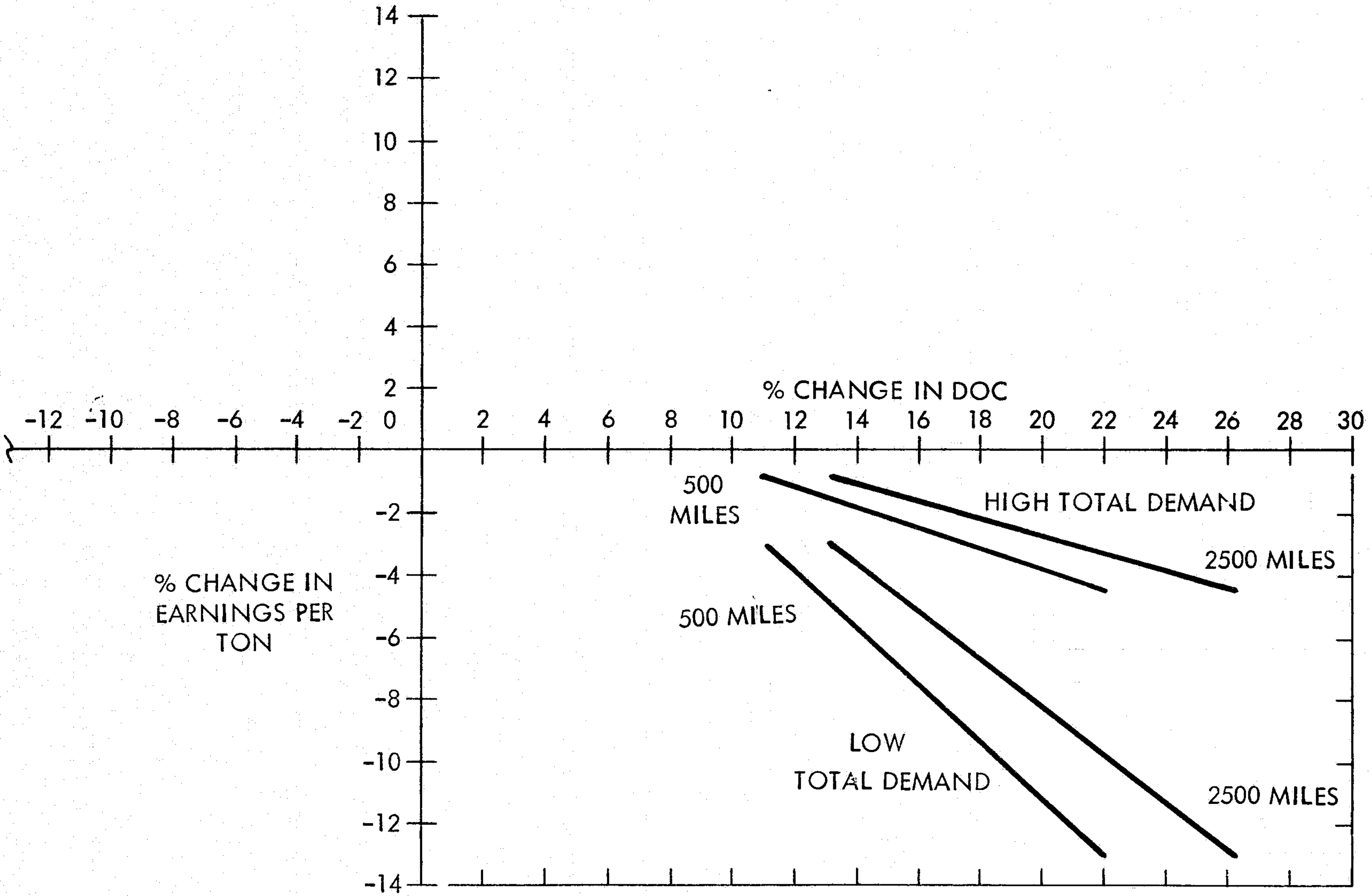


FIGURE V-17. SENSITIVITY OF EARNINGS PER TON TO DOC, D-70

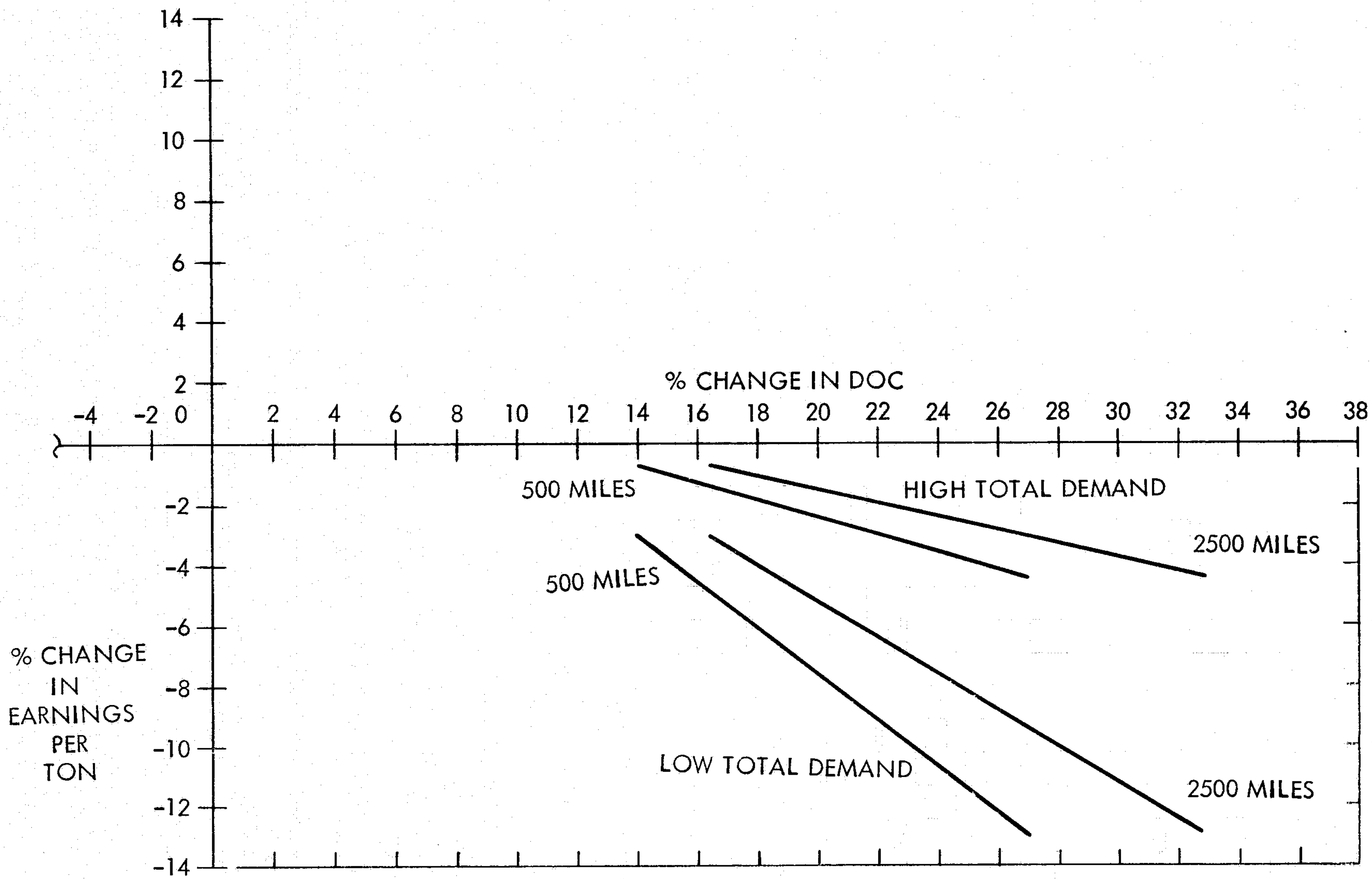


FIGURE V-18. SENSITIVITY OF EARNINGS PER TON TO DOC, D-330

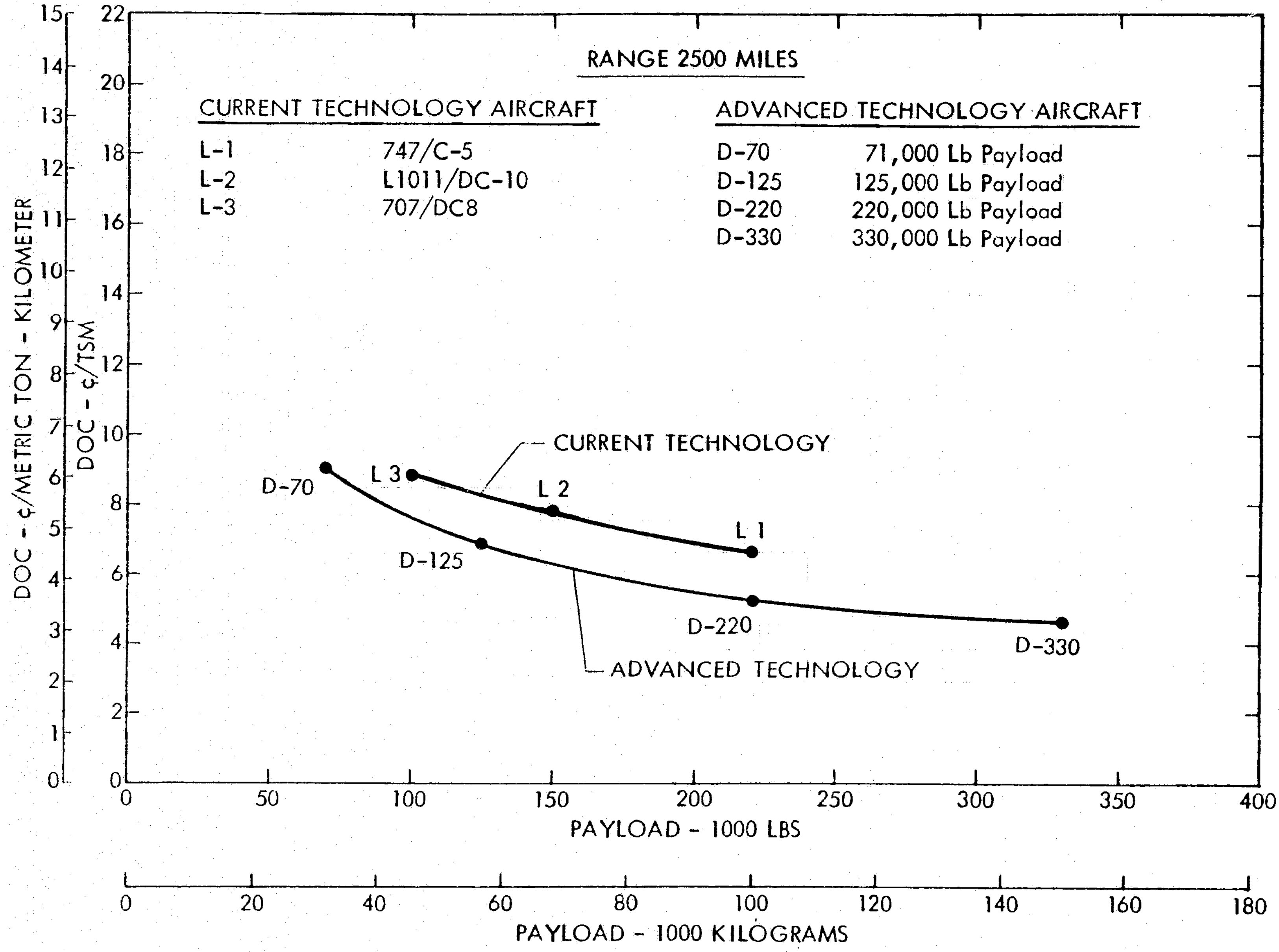


FIGURE V-19 TECHNOLOGY COMPARISON DOC

aircraft. The salient characteristics of the current technology aircraft are listed in Table V-11.

Effects of Reduced Indirect Operating Cost

A significant part of the cost of air cargo operations are classified as Indirect Operating Costs (IOC). These costs are associated with the ground operations, i.e., preparing the aircraft for flight (except maintenance). For air cargo operations, the costs of cargo traffic servicing at the airport are included in the IOC. In the following paragraphs, the elements of IOC are defined, the reduced costs associated with improved intermodal ground operations are described, and a comparison of the effects of conventional IOC and intermodal IOC on system operations is presented.

Indirect Operating Cost Calculation - The indirect operating expense functions established by the U.S. Civil Aeronautics Board in its "Uniform System of Accounts and Reports for Certified Air Carriers" are in the following categories:

- Direct Maintenance - ground property and equipment
- Applied Maintenance Burden - ground property and equipment
- Passenger service
- Aircraft servicing
- Traffic servicing
- Service administration
- Reservations and sales
- Advertising and publicity
- General and administrative
- Depreciation and amortization - ground property and equipment

There is no officially recognized standard method for calculating the IOC comparable to the standard method for calculating the DOC, ref. 2. A technique that is commonly used is one developed by Lockheed several years ago that treats each CAB designated cost element separately. This method is a sound basis for comparative analysis and is used in this analysis. In this method, the CAB designated elements are grouped according to the parameter that they are functions of. For example, Group A, Maintenance - Ground Property and Equipment, (GP&E) Aircraft Servicing and Depreciation (GP&D) have

TABLE V-11. CURRENT TECHNOLOGY AIRCRAFT

	AIRCRAFT DESIGNATION		
	L1	L2	L3
Max TOGW, Lb	770,000	450,000	330,000
Kg	350,000	204,000	150,000
Max Payload, Lb	220,000	150,000	100,000
Kg	100,000	68,000	45,000
Aircraft Cost 1977 $	38.3M	30M	16M
Single Engine Cost 1977$	1.5M	1.75M	625,000
Typical of	C-5/747	L-1011/DC-10	DC8/707

been found to be a function of the product of the number of aircraft departures and the maximum takeoff weight. The IOC expense grouping for all-cargo operations is given below:

	Expense	Parameter
Group A		
A_1	Maintenance - Ground Property and Equipment	
A_2	Aircraft Servicing (less Aircraft Control)	Aircraft Departures x Maximum Takeoff Weight
A_3	Depreciation and Amortization - Ground Property and Equipment	
Group E	Aircraft Servicing (Aircraft Control)	Number of Departures
Group G		
G_C	Cargo Traffic Servicing	Tons of freight, mail and express enplaned, measured in terms of shipment weight and number of pieces
Group H		Revenue freight ton-miles including effect of shipment weight
H_1	Reservations and Sales	
H_2	Advertising and Publicity	
Group J	General and Administrative	Indirect operating expense

With this system, simple formulas and coefficients determined from the CAB reports are used to compute IOC for conventional all-cargo operations. In this report, this is termed "conventional" IOC because it is derived from the current operations, and the costs thus calculated represent actual experience and cost allocations reported by the airlines to the CAB. It represents the conventional way of doing business by the airlines reporting to the CAB.

Improved Ground Operations - The scenario elements for intermodal air cargo operations described in Figure V-2 are different from conventional air cargo operations. Some of the intermodal functions are new, such as container delivery and pick-up in TL operations. Also, the locations where some of the functions are performed are different for the two modes; for example, the consolidation-break bulk functions are generally performed on the airport in conventional operations, but they are performed off-airport in the intermodal scenario. Because of the different scenarios, it is desirable to refine the IOC calculations for conventional operations to more accurately reflect the intermodal scenario. The cost of many of the CAB designated IOC elements will be affected by the improved ground operations in the intermodal scenario.

Maintenance - GP&E and Maintenance Burden and Depreciation - These functions include expenses related to the repair and maintenance of ground property and equipment. They also include the cost of maintenance material. Intermodal air cargo service will require only container handling equipment and property at the airport. Direct Maintenance of the cargo handling equipment and property for intermodal operations will be less costly than maintenance of conventional cargo handling equipment for processing individual shipments.

The cost of Aircraft Servicing and Aircraft Control functions will be the same for both conventional and intermodal operations.

Cargo Traffic Servicing and Servicing Administration comprises all cargo handling expense, including labor and administration pertaining to cargo handling. Intermodal service has a significant effect on this function because on-airport handling of individual shipments is eliminated in intermodal service. On-airport container handling and aircraft loading/unloading are substituted for this function in the IOC calculations. Handling of individual shipments becomes part of the pick-up and delivery operations in intermodal service as shown in the scenario, Figure V-2. IOC for intermodal operations include only the cost of handling containers at the airport and loading and unloading the containers into and out of the aircraft.

The detail work of Reservations and Sales required in intermodal air cargo operations will be reduced considerably compared with conventional service, because of the smaller number of units (containers) per aircraft load in relation to the number of shipments in conventional service. While the cost of this function probably cannot be reduced in proportion to number of containers vs. the number of shipments, a considerable reduction in cost is feasible.

The cost of Advertising and Publicity is determined to a large extent by competitive circumstances and managerial policy. It is assumed there will be no difference in the cost of these functions between conventional and intermodal operations.

General and Administrative costs are computed as a percentage of IOC less G&A in both coventional and intermodal service.

The basic method for computing conventional IOC based on the CAB reports is used to compute the intermodal IOC. Adjustments because of the different scenarios are made on the basis of estimated costs for each activity. The costs thus generated are used in the LP runs.

Comparison of Conventional and Intermodal IOC - Three sets of runs were made to evaluate the effect on operator potential profitability of the difference between conventional and intermodal air cargo service. The size of the shipment is one other factor that must be considered when comparing conventional air cargo operations with intermodal operations. The average shipment size reported in domestic operations in 1976 was 282 pounds (128 kg), whereas it is expected that intermodal operations will attract larger shipments in which average size would be upwards of 1000 pounds (454 kg). A three-way comparison has been made involving (1) conventional operations with existing average shipment sizes 282 pounds (128 kg), (2) conventional operations with intermodal size shipments 1000 pounds (454 kg), and (3) intermodal operations. Comparison of total earnings, E_T, for these three types of operations is shown in Figure V-20. This comparison addresses only airport-to-airport operations because this is considered to be most meaningful in terms of aircraft operator profitability. The scenario, Figure V-2, does not address the questions of ownership or who profits from the various functions. The aircraft operator's profitability certainly results from aircraft operations and logically from some on-airport operations. Therefore, it seems reasonable to base aircraft operator-profitability on airport-to-airport operations. From Figure V-20, we see that earnings increase when 1000-pound (454 kg) shipments are imposed on the conventional system. The intermodal system has the highest earning potential.

Comparison of Current and Advanced Aircraft DOC

The two previous sections examined the effects of changes in DOC and IOC, and this section examines their combined effects to provide a comparison of current and advanced, intermodal systems. To do this the LP model is run using only one aircraft at a time. The 747 is used as representing the current technology; the D-220 represents advanced technology.

Airport-to-Airport Comparisons - Comparison of total earnings for the three options of technology, operations and shipment sizes are shown in Figure V-21. The three horizontal bars across the bottom describe the three systems being compared. Similar comparisons of cost are contained in Figure V-22. Comparison of the left and center bars in Figure V-22 indicates a 20 percent reduction in airport-to-airport costs due to advanced technology and large shipment sizes. Comparison of the center and right bars shows additional 15 percent savings due to intermodal operations. Costs in the LP and on Figure V-22 are divided into two categories: aircraft costs, and traffic costs. Aircraft costs include the DOC and all of the elements of IOC except those related to cargo handling, namely: Cargo Traffic Servicing, Reservations and Sales, and Advertising and Publicity.

Door-to-Door Comparisons - As noted above, consideration of airport-to-airport operations is appropriate in the analysis of aircraft operator profitability. However, the shipper makes the crucial modal decisions based on

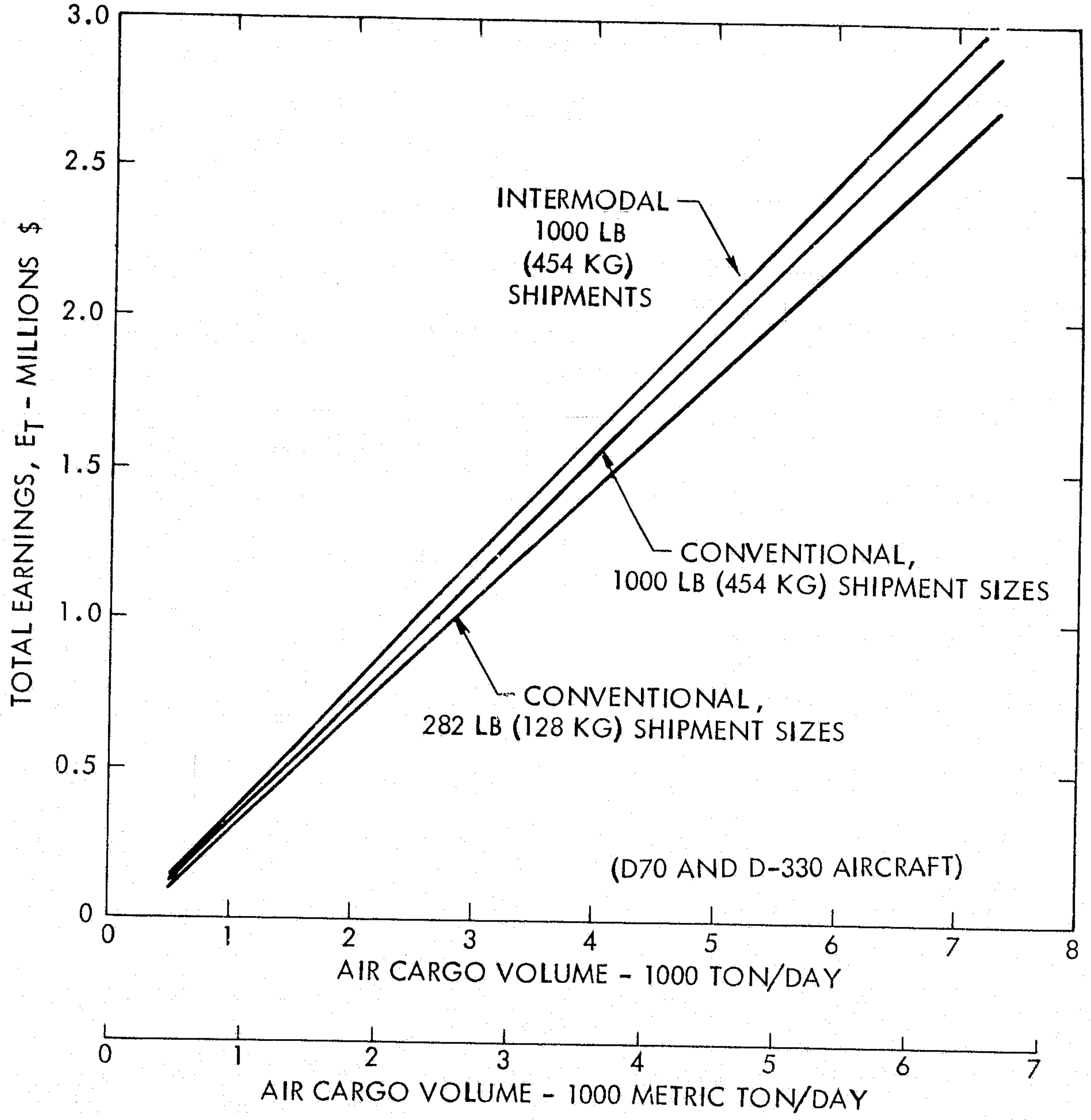
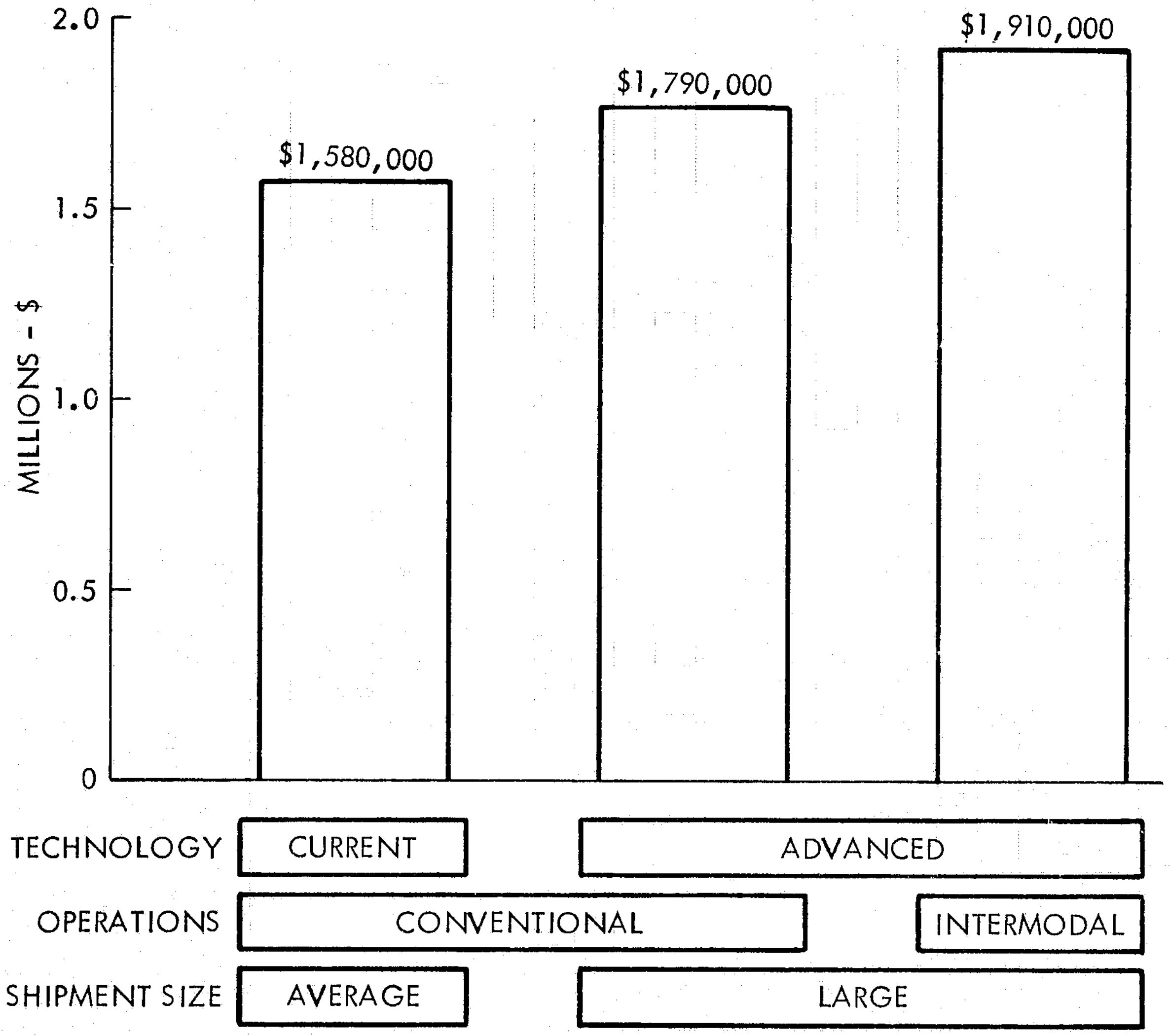
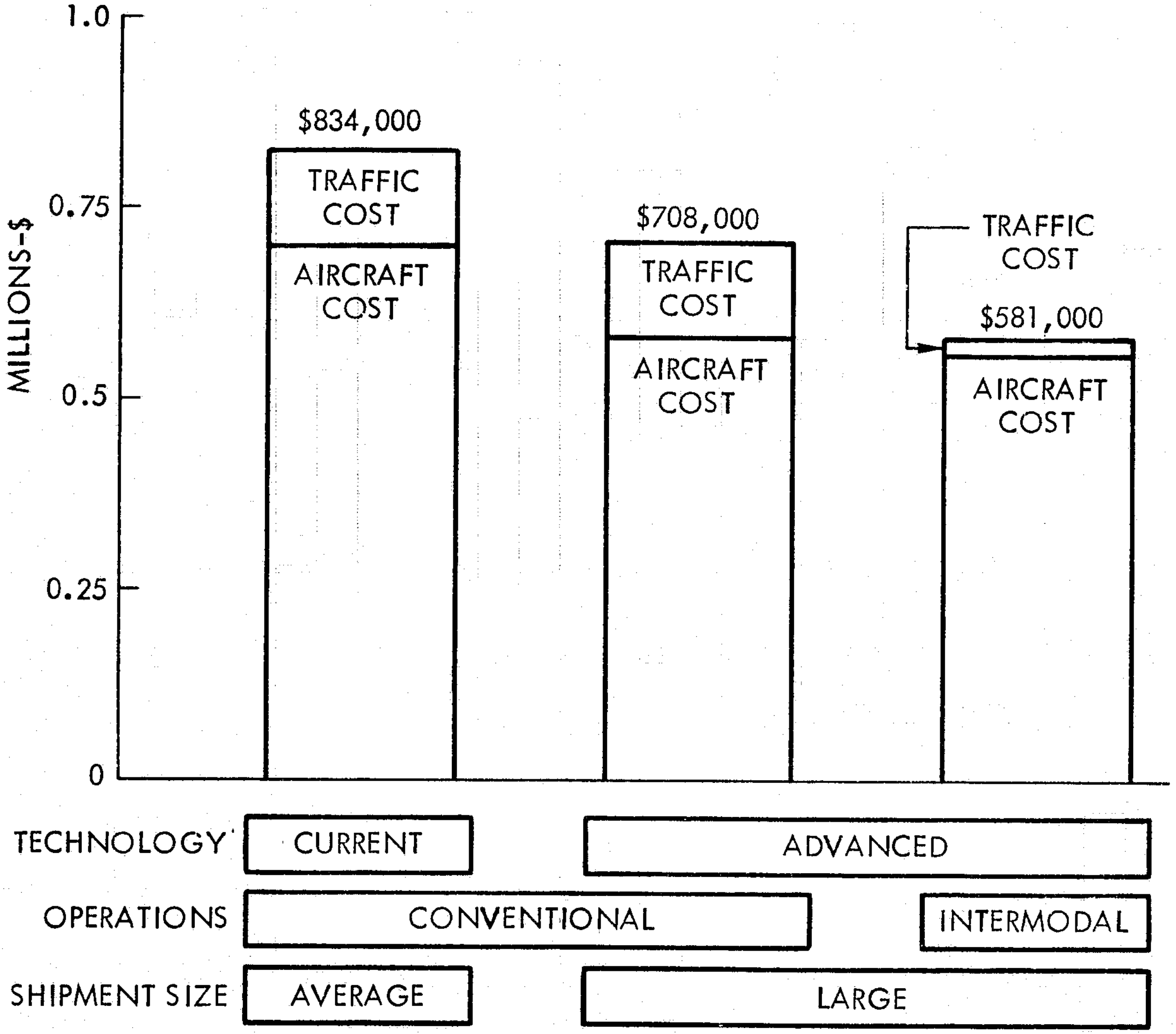


FIGURE V-20. EFFECT OF CHANGES IN IOC ON TOTAL EARNINGS



VOLUME = 4763 TONS PER DAY

FIGURE V-21. COMPARISON OF TOTAL EARNINGS.



VOLUME = 4763 TONS PER DAY

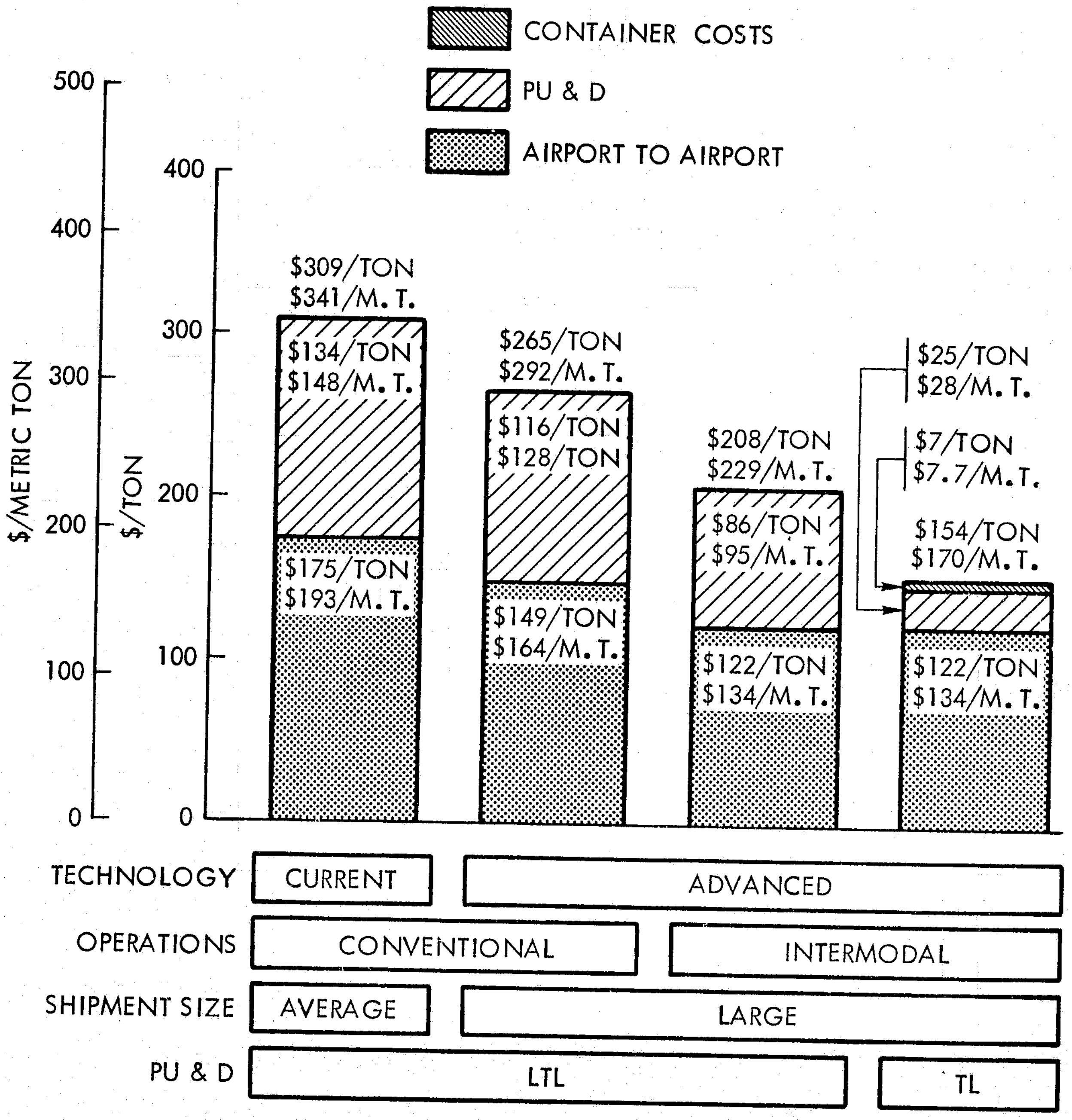
FIGURE V-22. COMPARISON OF COST AIRPORT-TO-AIRPORT door-to-door costs. These costs are presented in Figure V-23 in a comparative analysis by taking the airport-to-airport costs of the operator profitability analysis and adding the necessary costs to complete the door-to-door scenario in Figure V-2. The costs for the three operations in Figure V-22 have been determined for a payload of 4763 tons (4287 metric tons) per day. The average daily cost per ton is, therefore, $175 ($193 per metric ton) $149 ($164 per metric ton) and $122 ($134 per metric ton) for conventional current technology, conventional high-technology, and intermodal high-technology, respectively. The costs do not include air operators' profit. In this comparative analysis, it is not necessary to include this item in airport-to-airport cost.

In conventional operations the pick-up and delivery cost for average shipment sizes, less than 1000 pounds (455 kg), is $3.35 per hundred pounds ($7.44 per 100 kg) at each end of the movement (see Table V-2). This adds $134.00 per ton ($148.80 per metric ton) for a total door-to-door cost of $309.00 per ton ($341 per metric ton) as shown by the left bar of Figure V-23. The advanced-technology aircraft in conventional operations with large shipment sizes 1000 pound average (454 kg) incurs $116 per ton ($128 per metric ton) pick-up and delivery costs based on Table V-2 for a total of $265 per ton ($292 per metric ton). For the advanced-technology aircraft in intermodal operations, two options are developed: less than truck load (LTL) and truck load (TL). For LTL, the PU&D and consolidation-break bulk functions include: PU&D, platform handling, and billing and collecting for a total of $86.45 per ton ($96.00 per metric ton) based on ref. 4, Cost of Transporting Freight 1972, ICC Statement 2CIS-73, escalated to 1977 costs at the rate of the consumer price index. The total for this combination is rounded to $208 per ton ($229 per metric ton).

Development of the costs for TL operations is slightly more complicated. While there is no platform handling by the transportation company after the shipment leaves the dock, there is a real cost for loading the container by the shipper and unloading by the consignee. This is equivalent to one total planform handling in accordance with ref. 4. Although this cost may not be perceived, it is real and billing and collecting cost by the carrier adds $25.10 per ton ($28 per metric ton) to the TL cost.

In addition, two costs are not direct functions of the tons shipped: the cost of dropping the container at the shipping dock to be loaded by the shipper, and the cost of picking up the container after the consignee has unloaded it. This one-time cost for each container is $9.68 according to ref. 4.

The final cost that must be considered is that of the container itself. A rough approximation can be developed based on current intermodal container costs. If aluminum air intermodal containers, M_2, cost $24,000 each (approximately 3 times as much as the price of steel/wood current intermodal containers), the total capital and maintenance cost per year will be $4480 based on 15-year service life, 7 percent per year maintenance cost, and interest at 10 percent on half the capital investment.



VOLUME = 4763 TONS PER DAY

FIGURE V-23. COMPARISON OF COST, DOOR-TO-DOOR

At aircraft utilization of 3000 hours per year, the cost of a container while it is in the aircraft is $1.49 per block hour. If an average flight time is 4 hours, and assuming each container averages one flight per week, then each container averages 200 flight hours per year. Thus, each container space on an aircraft will generate the need for 3000/200 = 15 containers per year. Container use cost is thus $22.35 per aircraft hour. On an average domestic flight of approximately 4 hours, the total cost per container is $89.40.

If the average container contains 28,000 pounds (12,600 kg) or 14 tons (126 metric tons), the total cost per ton for the two functions of container drop and pick-up and container use is $7.07 per ton ($7.85 per metric ton). The total cost for the TL high-technology intermodal operation is rounded to $154 per ton ($170 per metric ton), Figure V-23. The total door-to-door cost benefits felt by the shipper or consignee are about 14 percent savings due to advanced technology and increased shipment size, another 22 percent due to intermodality, and another 26 percent if he can ship in truck load lots.

Analysis of Domestic Market

Analysis of a typical domestic air cargo operation was performed via means of the MACRO LP. The route system and demand are described in the following paragraphs.

Domestic Route System and Demand - The high and low levels of demand for this analysis encompass the upper and lower boundaries forecast for 1990 in Section III, 1990 AACS Forecast. Thus, the specific data points one wished to use are determined by selecting a specific market forecast and market share. The 1990 demand is distributed between a group of cities in accordance with the actual air cargo traffic reported in the 1972 census of transportation (ref. 1). Twenty-one routes between six cities were selected as typical of airline operators major routes. The routes and the percentage distribution are given in Table V-12. The air cargo demand on these routes included 76 percent of the traffic reported by the 1972 Census of Transportation. The distribution of demand for these cities is the distribution that existed between these cities in 1972.

The concept of the route system used in the analysis is typical of the route systems between regions surrounding the designated cities that could exist to meet the 1990 demand, assuming the demand is distributed in 1990 as it was in 1972. In this report, city names are used for ease of identification of regions. The route network is shown in Figure V-24. The demand on this typical network is about 7 percent of the total domestic demand. The 7 percent is a typical percentage of the total demand for one carrier to be satisfying, there being 15 air cargo carriers in the U.S. Therefore, this input is reasonably representative of one carrier's operations.

TABLE V-12. DOMESTIC ROUTE CARGO DISTRIBUTION

	Origin-Destination		% Distribution
1	NYC	DTT	4.4
2	NYC	CHI	4.8
3	NYC	IAH	2.7
4	NYC	SFO	2.8
5	NYC	LAX	3.8
6	DTT	NYC	6.3
7	DTT	SFO	4.5
8	DTT	LAX	2.0
9	IAH	NYC	4.3
10	IAH	CHI	1.4
11	IAH	LAX	2.1
12	SFO	NYC	9.5
13	SFO	DTT	1.2
14	SFO	CHI	1.8
15	LAX	NYC	13.1
16	LAX	DTT	2.6
17	LAX	CHI	6.5
18	LAX	IAH	1.6
19	CHI	NYC	18.8
20	CHI	IAH	3.1
21	CHI	LAX	2.7
			100%

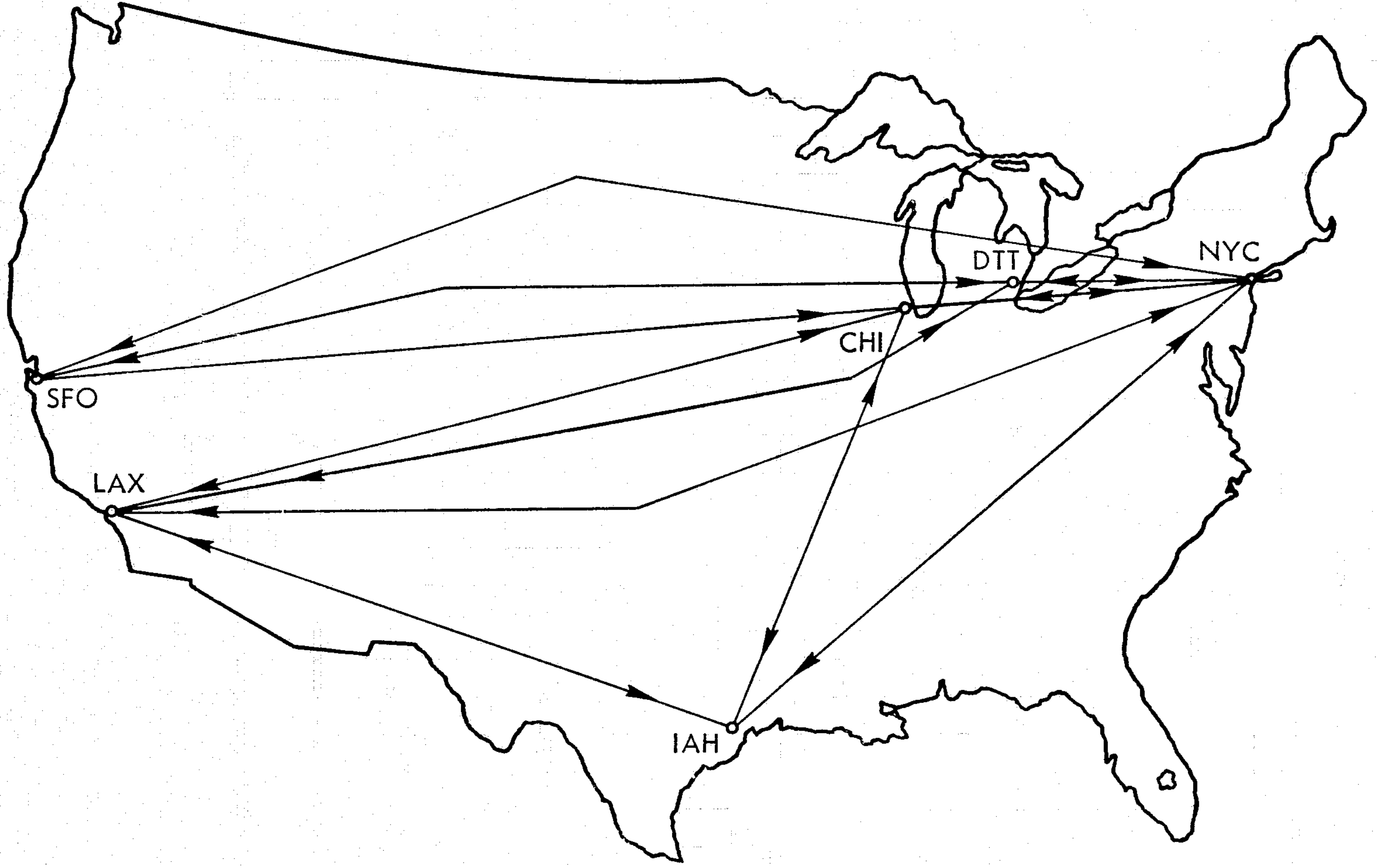


FIGURE V-24. DOMESTIC ROUTE SYSTEM

The route network and the associated demand spectrum based on the upper and lower boundaries of the 1990 forecast are used in the Air Cargo Analysis System shown in Figure V-1. This system then allocates candidate aircraft to the routes in a manner which maximizes earnings of the airline operator.

Domestic Cost - The revenue for transportation of the cargo is based on the 1977 general commodity tariffs. Values for a range of distances are selected from the tariffs and a regression equation is calculated. The equation for determining the rates for west-bound cargo is:

$$Y = 11.935 + 0.00985X$$

For east-bound movement, the equation is:

$$Y = 14.122 + 0.00685X$$

These equations are used to determine the rates per ton for the rate segments. Changes in revenue are implemented by factoring the rates equations by -15 percent, -30 percent, or -45 percent, as appropriate. The equations are plotted in Figure V-25.

Fleet Mix - The optimum fleet mix for each run in the series is shown in Figure V-26. Only two aircraft were selected by the LP, the D-70, and the D-330. The circles for aircraft hours, payload, and earnings represent 100 percent of the designated quantity. The divisions show the percentages of each quantity allocated to the specific aircraft.

Analysis of International Market

Analysis of a typical international air cargo operation via means of the MACRO LP parallels the domestic analysis. Most of the relationships detailed in the analysis of domestic operations such as profitability-volume, IOC and DOC - profitability effects and the effects of rates and frequency of service, are fundamental and inherent in any similar operation. Therefore, it is necessary to only confirm that the relationships developed in the domestic system are also applicable to the international system. Thus, the following report defines the specific international system inputs and describes the significant results that contain different information than the domestic analysis.

International Route System and Demand - The international route network, shown in Figure V-27, was developed to serve the import-export transportation requirements of the world trade contained in the OECD data bank. The system consists of 11 routes, for a total of 22 route segments for the LP run. They are listed in Table V-13E.

Five levels of demand were established for the international route system. As in the domestic demand, this range is designed to cover many scenarios upon which forecasts of the demand may be based. The designation of the levels of

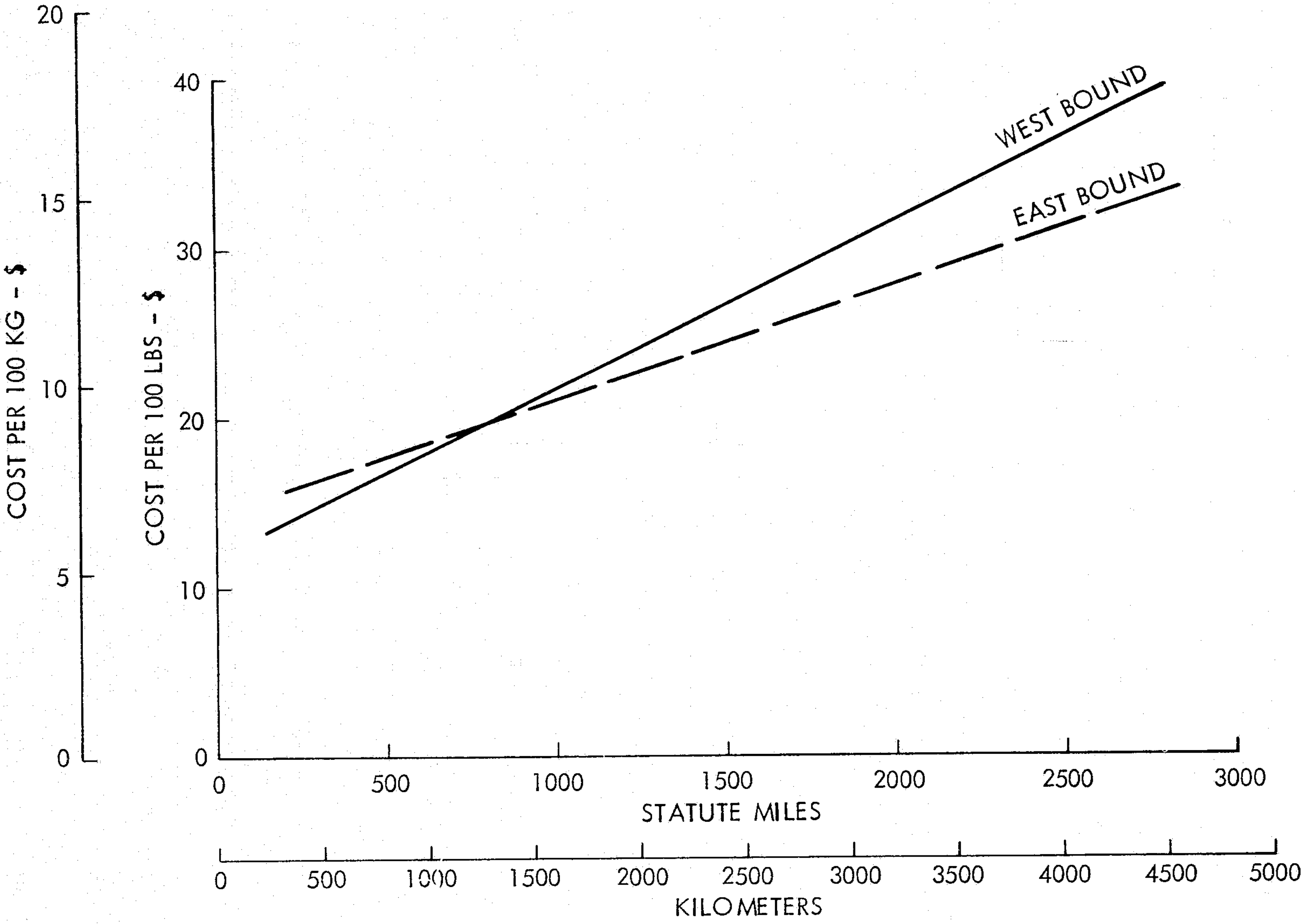
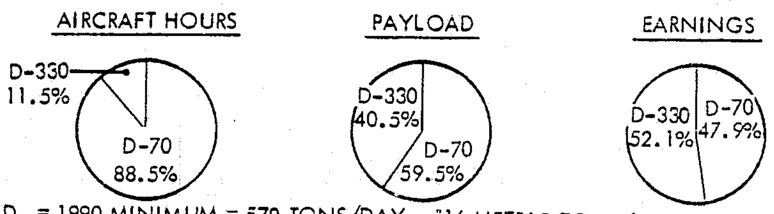
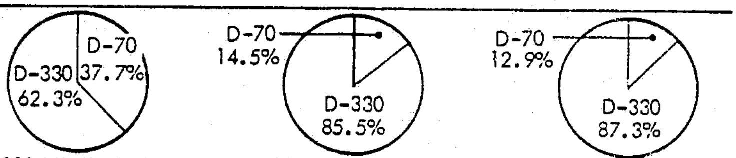


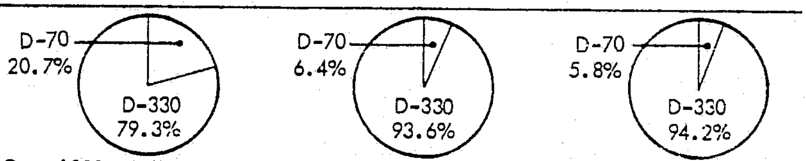
FIGURE V-25. AIR CARGO RATES REGRESSION LINES



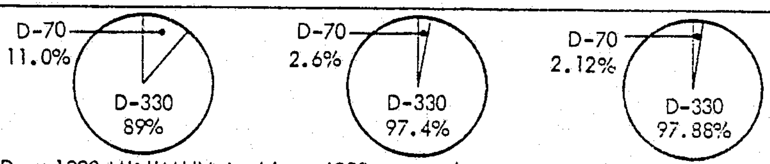
a. D_T = 1990 MINIMUM = 570 TONS/DAY ; 516 METRIC TONS/DAY



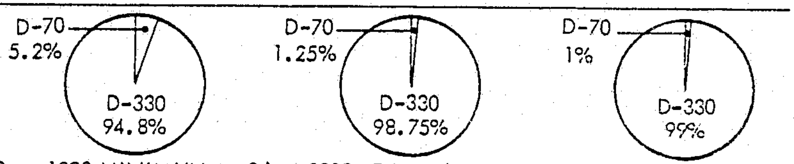
b. D_T = 1990 MINIMUM + .2Δ = 2511 TONS/DAY; 2278 METRIC TONS/DAY



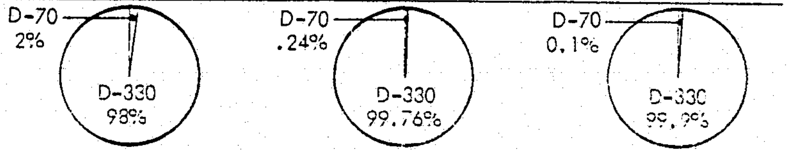
c. D_T = 1990 MINIMUM + .4Δ = 4452 TONS/DAY; 4039 METRIC TONS/DAY



d. D_T = 1990 MINIMUM + .6Δ = 6393 TONS/DAY; 5800 METRIC TONS/DAY



e. D_T = 1990 MINIMUM + .8Δ = 8333 TONS/DAY; 7560 METRIC TONS/DAY



f. D_T = 1990 MAXIMUM = 10275 TONS/DAY; 9322 METRIC TONS/DAY

FIGURE V-26. OPTIMUM FLEET MIX FOR DOMESTIC OPERATIONS

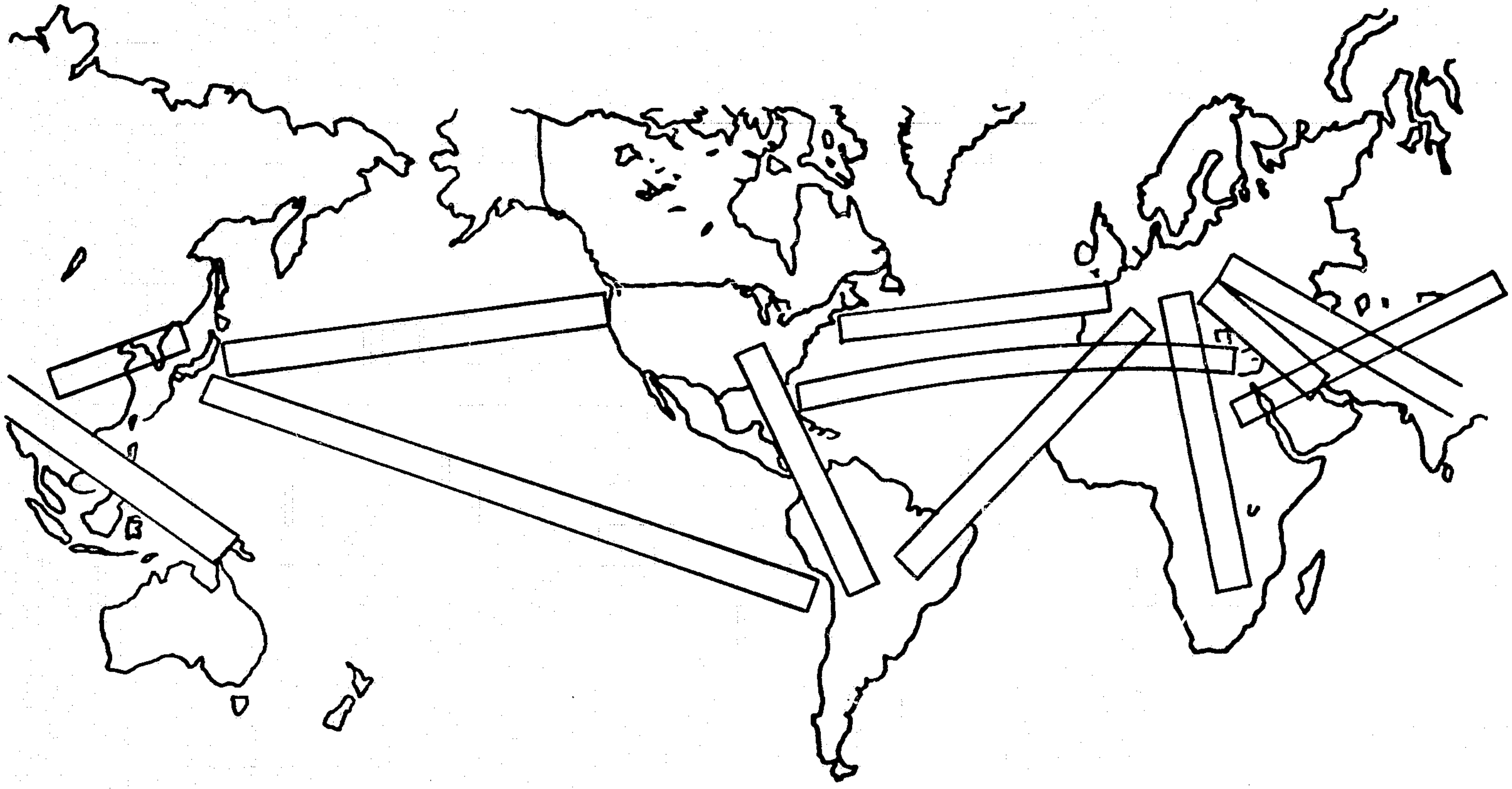


FIGURE V-27. INTERNATIONAL AIR CARGO ROUTE SYSTEM

TABLE V-13E. INTERNATIONAL ROUTES AND DEMAND

	Distance Miles	Demand - Tons Per Day				
		1980	1985	1990	1980 H1	1990 H1
1. Europe - North America	3,495	97	98	110	201	328
2. North America - Europe	3,495	88	88	93	143	233
3. Japan - North America	5,633	120	136	163	202	330
4. North America - Japan	5,633	104	127	150	162	263
5. South America - North America	4,470	63	72	83	119	194
6. North America - South America	4,470	64	74	84	116	190
7. Mid East - North America	7,000	16	18	21	25	41
8. North America - Mid East	7,000	27	35	44	48	78
9. Far East - Europe	8,309	64	74	81	146	237
10. Europe - Far East	8,309	65	63	62	93	152
11. Africa - Europe	5,483	28	25	16	63	102
12. Europe - Africa	5,483	138	150	164	210	342
13. Mid East - Europe	2,433	7	6	7	12	20
14. Europe - Mid East	2,433	52	59	67	120	196
15. South America - Europe	4,980	34	32	33	73	119
16. Europe - South America	4,980	44	44	44	95	155
17. Far East - Japan	2,600	72	91	112	97	158
18. Japan - Far East	2,600	103	124	146	203	330
19. Africa - Japan	6,500	7	8	10	11	18
20. Japan - Africa	6,500	41	54	67	78	127
21. South America - Japan	10,500	11	14	18	20	33
22. Japan - South America	10,500	20	26	32	34	55

TABLE V-13M. INTERNATIONAL ROUTES AND DEMAND

	Distance Km	Demand - Metric Tons Per Day				
		1980	1985	1990	1980 H1	1990 H1
1. Europe - North America	5,592	87	88	99	181	295
2. North America - Europe	5,592	79	19	84	129	210
3. Japan - North America	9,013	108	122	147	182	297
4. North America - Japan	9,013	94	114	135	146	237
5. South America - North America	7,152	57	65	75	107	175
6. North America - South America	7,152	58	67	76	104	171
7. Mid East - North America	11,200	14	16	19	23	37
8. North America - Mid East	11,200	24	32	40	43	70
9. Far East - Europe	13,294	58	67	73	131	213
10. Europe - Far East	13,294	59	57	50	84	137
11. Africa - Europe	8,773	25.2	23	14	57	92
12. Europe - Africa	8,773	124	135	148	180	308
13. Mid East - Europe	3,892	6	5	6	11	18
14. Europe - Mid East	3,892	47	53	60	108	176
15. South America - Europe	7,968	31	29	30	66	107
16. Europe - South America	7,968	40	40	40	68	140
17. Far East - Japan	4,160	65	82	101	87	142
18. Japan - Far East	4,160	93	112	131	183	297
19. Africa - Japan	10,400	6	7	9	10	16.2
20. Japan - Africa	10,400	37	49	60	70	114
21. South America - Japan	16,800	10	13	16	18	30
22. Japan - South America	16,800	18	23	29	31	50

demand, 1980, 1985, 1990, 1980 Hi, and 1990 Hi, are different than those used in the domestic case, which employed maximum and minimum and increments between. The system used in the international case is merely more convenient, and the designation does not necessarily relate to the year noted. The specific notations in each case are used only for ease in tracking the statistical data during the course of the analyses.

International Costs - The mission parameters and aircraft characteristics of the international aircraft candidates are given in Table V-4. Direct operating cost curves similar to the curves for the international aircraft are shown in Figure V-28.

When a specific route exceeded the maximum payload-range of the aircraft, the route analysis was performed by adding enough stops to enable the candidate aircraft to fly the routes with full payload. Costs for these routes will include DOC for all segments, IOC for one segment and aircraft servicing and aircraft control portions of IOC for each additional segment.

Cargo rates for the international cargo movements were taken directly from the tariff published in October 1977. Typical origins and destinations representing each route segment were selected but the data did not lend itself to linearization as in the case of the domestic rates. The data were scattered in relation to costs per mile; therefore, the actual rates for typical origin-destinations were used.

The indirect operating cost (IOC) for the international network were developed in the same manner as the IOC for the domestic network. Since scale factors for most IOC functions are different for international and domestic IOC, the IOC for international operations is higher than for equivalent domestic operations. The international air cargo data were applied to the air cargo analysis system previously described, Figure V-14. The results of the computer runs are described in the following paragraph.

International Fleet Mix - The fleet mix selected in the computer run is shown in Figure V-29. It consists of three aircraft: I-125, I-220, and I-330. As the magnitude of the payload increases, the percent carried by the I-125 aircraft decreases rapidly, while the percentage carried by the I-220 increases moderately and the percentage carried by the I-330 increases more rapidly.

Aircraft Size and Fleet Mix Analysis

From the data derived from the MACRO Route Analyses both domestically and internationally, it is quite evident that market size and share of the market have a direct effect on fleet mix.

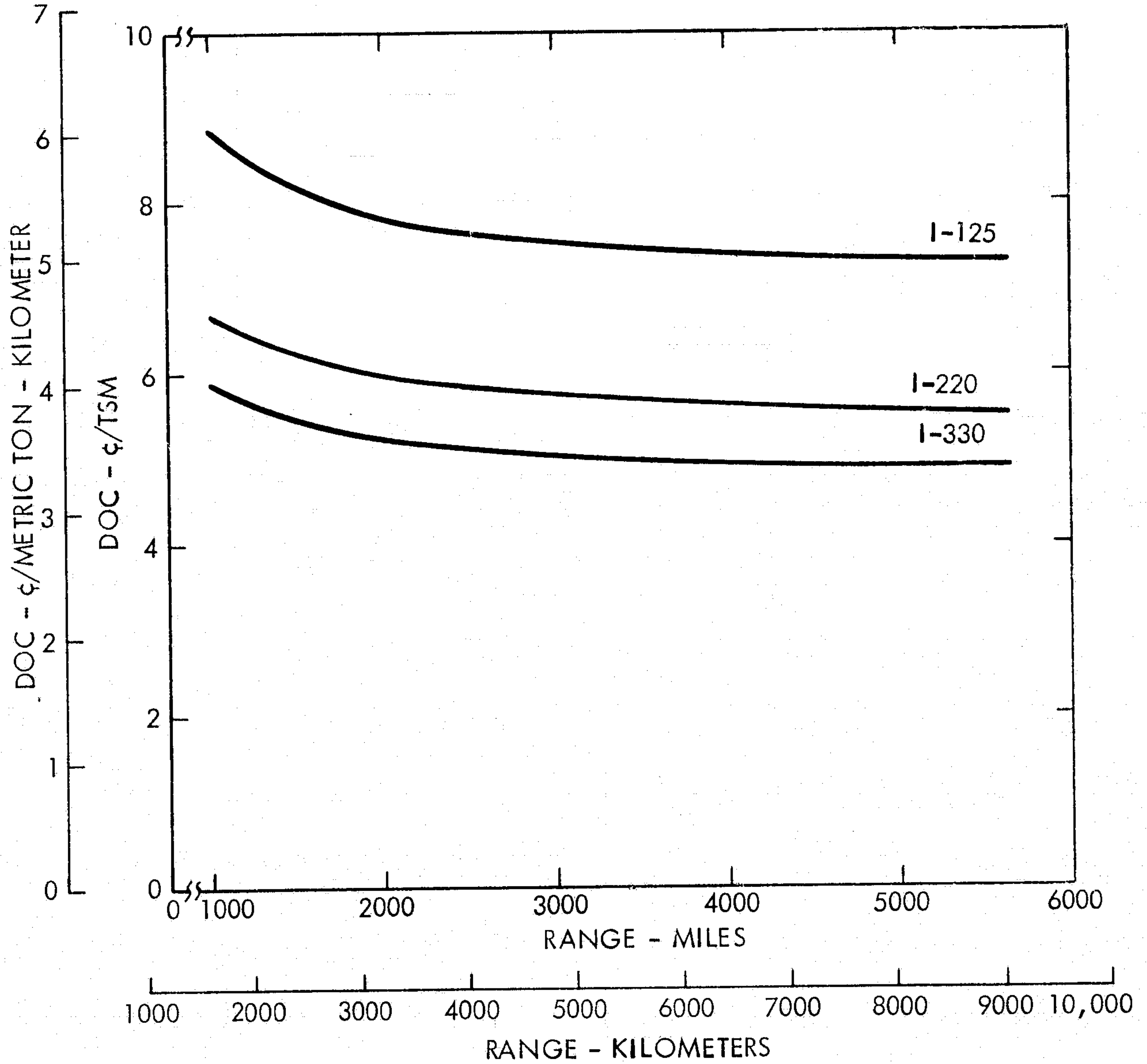


FIGURE V-28. INTERNATIONAL AIRCRAFT DOC

Domestic - For the domestic analysis, the MACRO was the choice of four advanced technology aircraft as follows:

D70

D125

D220

D330

The specific characteristics of these aircraft were given earlier in this section.

The maximum domestic cargo demand in 1990 was 32,000 tons per day for the total representative U.S. domestic system which consisted of six city pairs. As shown on Figure V-26, the fleet mix analysis was conducted on reduced number of daily tons so as to represent various levels of a potential oerator's share of the market, the minimum being 570 tons per day (516 metric tons per day) and the maximum being 10,275 tons per day (9322 metric tons per day). Six levels of market share were considered, representing 2, 8, 14, 20, 26, and 32 percent of the total. It is of interest to note that the set of data in Figure V-30, representing a 2 percent (570 tons per day; 516 metric tons per day) share of the market, indicates that the D-70 aircraft consumes 88.5 percent of the operational hours while moving 59.5 percent of the cargo and contributing only 47.9 percent to total earnings. This fleet mix requires 87 percent D70 and 13 percent D-330's. The most significant changes in fleet mix occur when the operator's share of the market changes from 2 to 8 to 14 percent. Once a volume of 4452 tons per day (4030 metric tons per day) is reached, fleet mix requirements remain fairly stable with approximately 18 percent D-70 and 82 percent D-330 aircraft.

International - The maximum international daily air cargo demand in 1990 was 37,000 tons (33,300 metric tons) for the total system. As shown in Figure V-29, the daily demand was reduced to represent various levels of potential operator's share of the market; the minimum is 1262 tons/day (1135 metric tons/day) and the maximum is 3701 tons/day (3331 metric tons/day. The MACRO was offered four advanced technology aircraft:

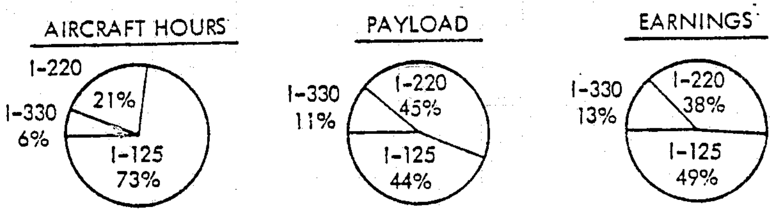
I-125

I-220

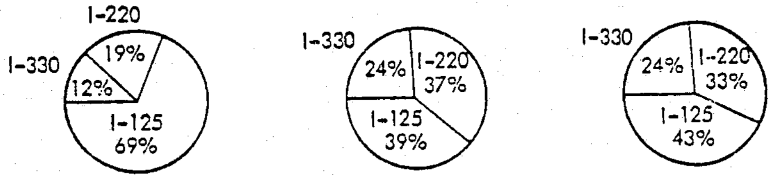
I-330

I-440

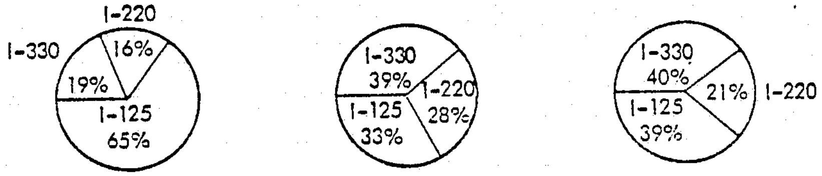
The specific characteristics of these aircraft were also provided earlier in this section.



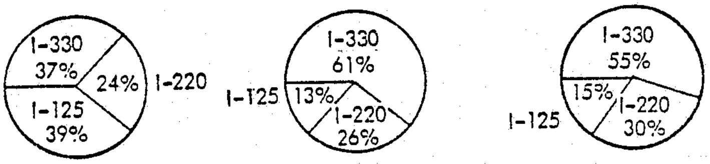
a. D_T = 1262 TONS/DAY; 1135 METRIC TONS/DAY



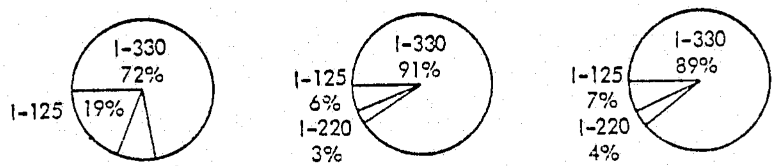
b. D_T = 1409 TONS/DAY; 1268 METRIC TONS/DAY



c. D_T = 1603 TONS/DAY; 1443 METRIC TONS/DAY



d. D_T = 2271 TONS/DAY; 2044 METRIC TONS/DAY



e. D_T = 3701 TONS/DAY; 3331 METRIC TONS/DAY

FIGURE V-29. INTERNATIONAL FLEET MIX

Results - The results of the international fleet mix analysis was different from the domestic in that three aircraft sizes were selected instead of two. The fleet mix requrements stabilize after the operator's share of the market exceeds 10 percent which is similar to the domestic analysis. With a 4 percent share of the market, 1409 tons/day (1268 metric tons per day), the fleet mix is comprised of 59 percent I-125's, 35 percent I-220's, and 6 percent I-330's. With 10 percent or more of the market share, 3701 tons/day (3331 metric tons per day) the fleet mix changes significantly to 14 percent I-125's, 4 percent I-220's, and 82 percent I-330's.

In the final analysis, the data indicates that for post 1990, both domestic and international operations require an airplane in the 330,000 pound payload (150,000 kilos) range and a smaller aircraft, probably a feeder type, of 70,000 to 125,000 pound payload (32,723 to 110,000 kilos). It is unlikely that an intermediate-size aircraft (i.e., I-220) would be developed because of the small number required.

The results of the aircraft size and fleet mix analyses produced a total fleet mix requirement for both domestic and free-world international markets. These aircraft requirements were developed for 1990 and 2000 to get a better understanding of what changes might occur over the initial operational time frame for an AACS.

	1990		2000	
	Low	High	Low	High
Domestic				
70,000 Lb. (32,000 Kilos)	34	34	40	31
330,000 Lb. (150,000 Kilos)	51	65	42	74
International				
125,000 Lb. (57,000 Kilos)	105	45	64	39
330,000 Lb. (150,000 Kilos)	61	213	104	408

Summary of Findings

Based on the projected price-demand relationship remaining relatively elastic through 1990 with rate reductions of 45 percent, airline operators' marginal earnings remain positive. That is, each ton of additional cargo will produce additional earnings.

Increased frequency of service to satisfy service sensitive demand reduces potential profitability, but as the overall demand increases, the frequencies, even with the largest aircraft, are probably above the threshold of service requirements. Efficient scheduling can solve service-sensitive, low-volume market problems with minimum effect on profitability.

The reduction in direct operating cost associated with advanced-technology aircraft and the opportunities for economies of scale available in intermodal operations provide the potential for overall cost reductions that are commensurate with the rate reductions in the price elasticity of demand of the forecast for 1990.

The aircraft fleet requirements for optimum domestic operations indicate a need for 57 to 65 new 330,000-pound (149,685 kg) payload intermodal freighter by 1990.

The upper boundary of the international air cargo demand forecast results in requirements for 213 similar 330,000-pound (149,685 kg) payload aircraft. Thus, the combined requirements for a basic aircraft of this size, including both short- and long-range versions in 1990, could be as high as 278.

In addition to the 330,000-pound (149,685 kg) payload aircraft, there is a transient requirement for smaller aircraft. The analysis indicates requirements for 71,000 (32,204 kg) pound payload aircraft in domestic service and both 125,000 (56,699 kg) and 220,000-pound (99,790 kg) payload aircraft in the international operations. After 1990, the need for these aircraft decreases as the market continues to grow. More detailed analysis is needed to investigate alternative means of satisfying this need.

VI - ELEMENTS AND SEQUENCE OF CRITICAL EVENTS

Introduction

Although cargo has been carried on aircraft since the 1920's, air freight other than mail was not seriously considered as a viable freight mode until the late 1940's. Major technical break-throughs during this period in high-speed aerodynamics and the jet engine brought forth the modern-day passenger jets which have been subsequently converted to all-cargo configurations. These events led to many optimistic projections over the years that air cargo was about to become of age. However, although there has been significant growth in air cargo over the last 20 years, it has yet to realize its full potential. Many users of air cargo still look upon this mode as being strictly an emergency means of moving their goods, and they have not planned to consider it for routine use in the near future.

Now, as revealed by the Case Study results presented in Section II of this report, there is a definite change in user attitude toward the future of air cargo. The users indicated they would make routine use of an advanced air cargo system such as that postulated in the 1990 Transportation Scenario. This section deals with the elements and critical events necessary to the definition, planning, and implementation of an advanced air cargo system.

Elements

If the Advanced Air Cargo System is to gain the use predicted by the Case Studies, a number of elements must be identified, resolved, and in place in the minds of the user:

- An efficient, effective, intermodal cargo aircraft.
- A compatible set of transportation equipment, containers, and rolling stock that are interchangeable among modes and captive to none.
- An agreed-upon set of ground-interface equipment.
- Interchange agreements between all modes as to the use and responsibility for the above.
- Door-to-door through-service with consolidated tariffs and bills-of-lading.

These elements are important in the minds of the users (shippers, consignees, and surface transportation companies) because each is necessary to bring about an operational system that represents a significant improvement over today's system projected to 1990.

Critical Sequence of Events

The development of an expanded air cargo market and an advanced air cargo system is critically dependent upon the timely occurrence of a series of actions and events involving both the private sector and governmental agencies. That series is depicted in Figure VI-1. The upper branch addresses the civil need and technological capabilities. The NASA Precursor Program is a good example of an activity now in progress on that branch; the recommendations of Section VII of this report also fall on that branch. The lower branch of Figure VI-1 addresses the organizational/administrative/financial aspects which must be resolved to enable the advanced technology to be used to satisfy the demand. An excellent example here is the "Issues of Commonality" study to be contracted for later this year by the Air Force, using Air Force and NASA funds.

The following discussions expand the blocks of Figure VI-1; the numbered items refer to the block numbers on the figure.

1. An essential first step is recognition and acceptance of the significant potential growth in the air cargo market which would result from the advent of an advanced air cargo system - designed from the outset as a fully compatible element of an integrated national transportation system.

2. General agreement must follow on the need for an all-new freighter aircraft as an essential element of the advanced air cargo system. An advanced-technology air freighter is essential to enable commercial operators to provide high-quality service at price levels necessary to promote the projected demand. The potential benefits that could accrue might prove enormous, ranging from substantial cost reductions, to improved earnings, to the opening of entirely new markets, to trade expansion, to improved balance of trade.

3. The first step on the lower branch is acceptance by commercial carriers and the military of the need for a joint industry/government program to obtain common objectives. The military need for additional outsize strategic airlift is generally accepted; only the precise quantification of that need remains. A combination of that military need with the civil need from block 2 should allow acceptance of a joint program. Neither the civil nor military sector alone is likely to obtain adequate funds or other essential support toward the development of an advanced large cargo aircraft which both need. An advanced air freighter, developed under a joint military/commercial development program and priced to commercial operators at a level that

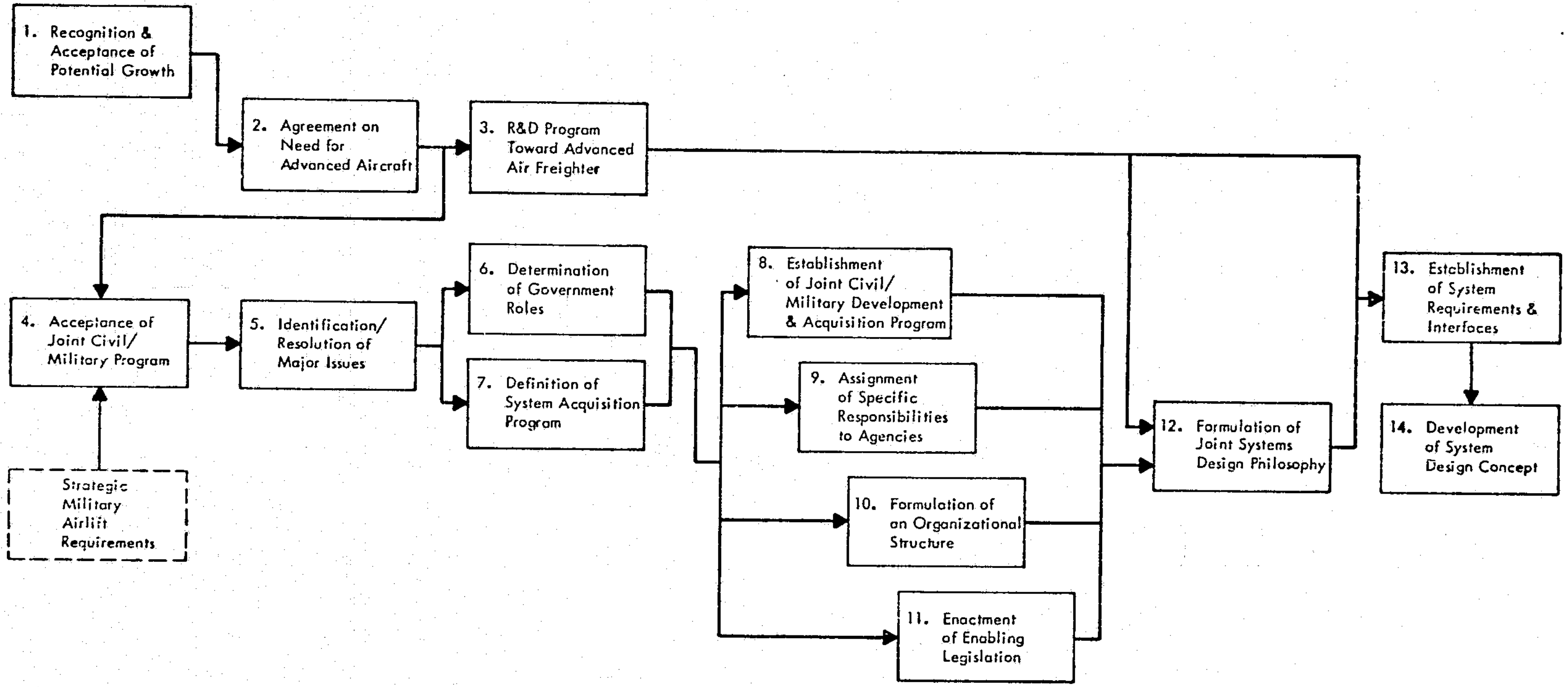


FIGURE VI-1. CRITICAL SEQUENCE OF EVENTS offered lower total operating costs than other available aircraft, would not only reduce the government investment required to satisfy world-wide national defense commitments but could generate a profitable stimulus for commercial air cargo. The prospect of unremitting economic pressures of continuing inflation and corresponding constraints on both private industry and defense financial budgets strongly suggest that a government-industry partnership may offer the only satisfactory solution of basically common objectives in improved air cargo transportation.

4. Many issues will require early identification and resolution before a joint civil/military program for the development and procurement of a common advanced cargo aircraft system can be judged practical and can proceed. The Air Force (ASD/AFSC) is currently evaluating industry proposals for conducting a comprehensive examination of all issues related to the acceptance of a commonality concept. Aircraft design options are being addressed by separate current Air Force study efforts. A principal objective of this effort is to define each issue, including the background and fundamental causes and the analysis of events necessary to resolve selected issues. Among other things, the "Issues of Commonality" study will prioritize issues according to criticality to the successful completion of a common aircraft program. This study is considered to be an essential precursor to the formulation of a successful program plan for the acquisition of a joint civil/military cargo aircraft.

5. The government's role in facilitating the development of the advanced air cargo aircraft must be determined. The degree/extent of joint government-industry participation, the nature and extent of planning influence and division of management responsibilities, the formula for sharing financial burden, among other things, need to be addressed and resolved during the concept-definition phase of the proposed program.

6. Under present system acquisition processes, the development and production time period for a commercial air freighter (4 years) would be much shorter than that for a military cargo aircraft (9 years). In recognition of these lead times, a firm go-ahead decision must be made during the mid/late 1980's to meet the projected market demand.

7. The joint civil/military development and acquisition program must be formally established as a matter of national priority by the Executive and Legislative Branches of the Government.

8. Specific responsibilities in the joint civil/military air cargo system development and acquisition program must be assigned to individual governmental agencies. The decision to assign primary government responsibility to the DOT or to the DOD would be an important influence on whether the aircraft design would favor commercial needs or military needs. One way in which all the diverse interests and posibly conflicting policies may be brought into proper perspective

and resolved might be to assign the responsibility to a single federal agency and to establish a joint government-industry commission to provide policy guidance to that agency. Such a commission, established by the Executive Branch, might be composed of representatives from the legislative and executive branches, the DOD, other government agencies, and leaders of the air and surface transportation industries.

9. An organizational structure must be formed with appropriate private sector and/or government representatives for the planning and management of the civil/military large cargo aircraft development and acquisition program.

10. Appropriate legislation must be enacted to develop an efficient airfreight transportation system for both the civil and military sectors and to enable/ensure that the civil operators, the DOD, the DOT, and NASA work together to achieve this goal.

11. A basic system design philosophy must be formulated which is mutually acceptable to both potential commercial operators and the Air Force.

12. System requirements and interfaces must be derived and integrated based on the system design philosophy. Air craft payload, range, design density, cargo compartment dimensions, loading methods, terminal requirements, container interface requirements, and ground handling requirements will be specified.

13. The system design concept can then be finalized with the appropriate aircraft, facility, ground equipment, and personnel elements.

VII - CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE STUDIES

Conclusions

Although a great deal more work and analyses are needed, the NASA Cargo/Logistics Airlift study has provided with several preliminary findings:

1. There is a need for a dedicated advanced air cargo system as indicated by the industry/transportation company Case Studies. The shipper/consignee is interested primarily in lower rates and faster, reliable service. He is definite and specific in his desire for an intermodal container and/or trailer with dimensions of today's surface equipment that he can load himself as a partial load or a full truckload.

   The surface carriers - truck, rail, and ocean - also indicate considerable use of an advanced air cargo system as a substitute service, similar to that of rail piggyback. Again, the surface carrier wants his future intermodal equipment to be accommodated directly by the aircraft.

2. Based on the domestic and international case studies, the air cargo demand forecast shows that the introduction of an integrated advanced air cargo system would, in fact, stimulate the market place to an extent that development of a next-generation, dedicated air freighter is indicated. At this time, it appears that the international market for the aircraft is approximately 3 to 4 times as great as for the U.S. domestic market.

3. The economic analysis of the air cargo market indicates that, with the application of advanced technology and more efficient intermodal handling of the freight, door-to-door air freight reductions of 45 percent, from today's rates, may be achievable.

Recommendations

Lockheed's recommendations fall into two areas: (1) the market and (2) system analyses and technology development.

Market - In the area of the world air freight market, it is recommended that further case study analysis be undertaken. Lockheed was gratified to find the high level of interest and cooperation exhibited by the prestigious companies that responded, and the wealth of valuable information they provided. It would be most beneficial if additional questions could be directed to selected companies in specific commodity groups.

Next, beyond those already conducted, additional case studies in the international market are needed. International air cargo potential looms several times larger than U.S. domestic potential in the 1990's. the relatively modest number of international case studies should be expanded to balance the domestic data bank.

The third area recommended for additional study also addresses the international market, particularly potential changes in distribution and manufacturing patterns. A more in-depth study is needed of this trend, which was observed in several of Lockheed's foreign case studies. Significant shifts in the location of sub-assembly and finished goods operations will probably impact the demand for improved and expanded air cargo service.

Finally, the potential of new markets, wholly apart from those addressed in this study, merits attention. Those are the markets created by developing nations and by major changes in geopolitical relationships, such as those of mainland China and Russia.

All of these studies would help increase the confidence level of the CLASS market projections and further illuminate some of the opportunities and hazards in the rapid growth period ahead.

<u>Technology</u> - With a good estimate of the market base in hand, we need to identify those areas of analysis and technology required to make the advanced air cargo system economically and environmentally sound.

First, a refined payload and fleet size and analysis should be made to establish the preferred size and quantity of aircraft, because aircraft size and fleet mix are sensitive to the market size and the operator's share of the market. Since the initial efforts of the CLASS program investigate only one slice in time, 1990, it is most important to recognize that these data do not actually reflect the complete operational time frame for an advanced technology dedicated air freight system. The potential operational time period is more like 1990 to 2020. Lockheed recommends using computer models for further parametric payload analyses based on updated market forecast. This would provide an insight into the needed aircraft size and would help identify a family of aircraft with sufficient growth capability to satisfy the complete time frame. These studies should be carried out in conjunction with a select group of domestic and foreign air cargo carriers, surface freight transportation companies, and shippers and consignees. In this way, the freight transportation user and operator can share their operational experience and be a party in the shaping of initial future plans. This will enable NASA to better determine: (1) what technology developments will be available, (2) how and when the technology may be applied, (3) what size aircraft best accommodates the market, and (4) the market size.

Second, there is a need to identify and assess environmental concerns and their demands on technology. Concerns involving fuel conservation, engine emissions, and noise footprints are becoming more and more prominent. For example, noise constraints are reflected in the trend toward imposing nighttime curfews at many key foreign and a few domestic airports. Yet, air freight must move by night to achieve its full potential.

A major application of and challenge to advanced technology will be to achieve a "quiet night freighter." The technology areas of propulsion, acoustic suppression, aerodynamics, and advanced materials must be examined and pursued toward the end of developing an advanced air cargo system capable of operating from airports during the night hours. These are specific problem areas that impose more stringent requirements on cargo aircraft out of the necessity to operate at night. There are numerous trade-offs, for instance, in airport performance between high-lift devices, engine nacelle acoustical treatment, engine selection and location, application of composite structure and leading-edge/flap laminar flow control. These trade-offs should be examined for various configuration arrangements which consider fuselage length and width, variable incidence wing, high/low wing location, blended wing-body combinations, and cargo/passenger combinations which do not compromise cargo operations for an advanced-technology, dedicated air freighter.

Third, with the expressed need to lower door-to-door air freight shipping costs Lockheed recommends that these technology applications be examined in detail to determine which combinations might lead to lower operating costs, and hence, lower air freight rates.

Armed with the facts from future studies of this scope, NASA can identify the levels of technologies required for the best economies, and the timing for the development and application of these technologies.

Each of these areas should also be examined to identify and assess more closely the limiting technology and environmental constraints on future air cargo operations.

All of this leads to the point that experience shows it takes 12 to 15 years to bring a system from its initial conceptual phase to operation. As shown in Figure VII-1, 82 percent of our case study participants indicated a need for the advanced air cargo system to be operational by 1990. In light of this fact, NASA is urged to pursue these future study recommendations with a minimum of delay.

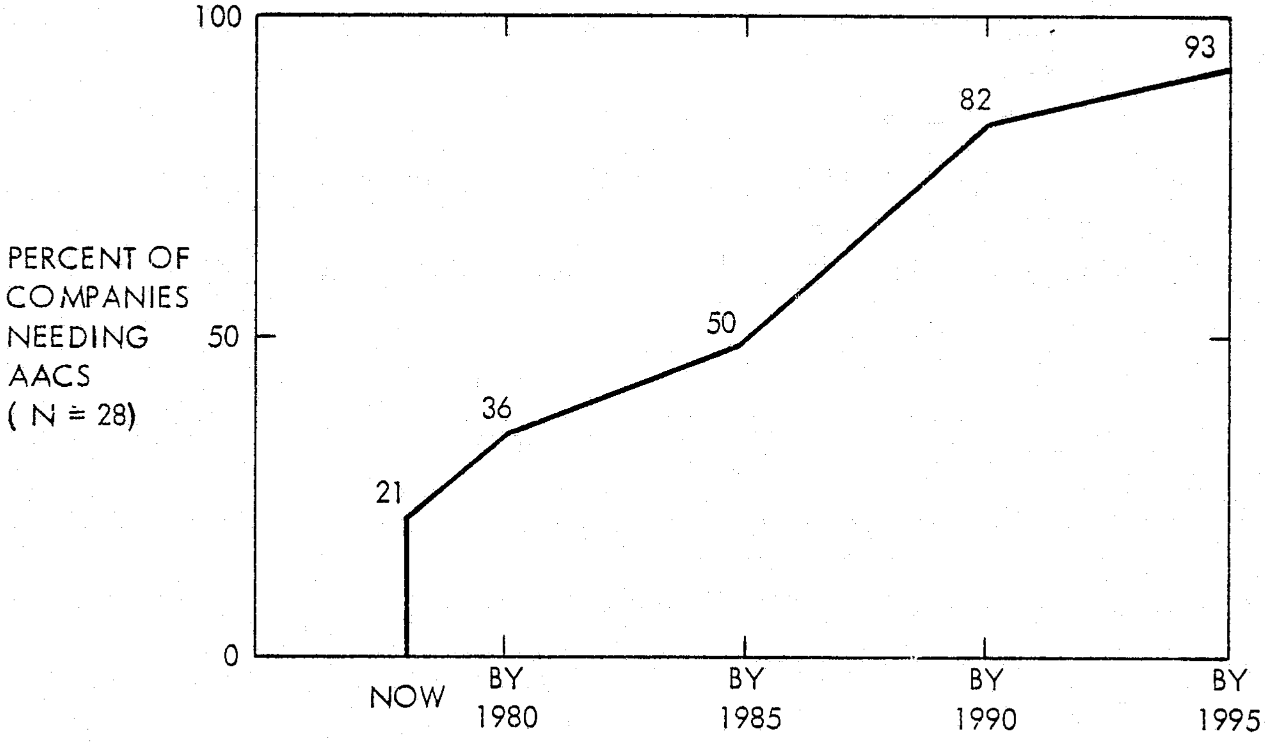


FIGURE VII-1. TIMING OF NEED FOR AACS

REFERENCES

(Section I)

1. Air Cargo Guide. Ruben H. Donnelley Corporation, August 1977.
2. Commodity Transportation Survey, Census of Transportation. U.S. Bureau of Census, 1972.
3. U. S. Foreign Trade Data Series. U.S. Department of Commerce, Compiled for October 1976.
4. Service Segment Data (ER 586). Civil Aeronautics Board.
5. CAB Data on U.S. Carriers. Civil Aeronautics Board.
6. IATA Cost Committee Studies. International Air Transport Association.
7. Domestic Air Freight Investigation (DAFRI), Docket No. 22859. Civil Aeronautics Board, 1975.
8. Commodity Attribute File. Transportation Systems Center, Department of Transportation.
9. Potential Air Commodity Identification; a Suggested Methodology. Boeing Commercial Airplane Company, 1977.
10. The Air Cargo Market in the United States to 1985. Frost and Sullivan, Inc., January 1977.
11. The Nature of Air Cargo Costs. University of Washington, 1967.
12. IATA Cargo Automation Research Report (CART). International Air Transport Association, 1975.
13. Gibson, J. S.: A Preliminary Look at Aircraft Noise Factors, Curfews, and Nighttime Operations. TB78-01, Lockheed-Georgia Company, 1978.
14. Senators Nunn and Bartlett: NATO Inspection. Senate Armed Services Committee Report.

(Section III)

15. Facts and Trends. Transportation Association of America.
16. U.S. Department of Commerce, Bureau of the Census, FT 990.
17. National Transportation, Trends and Choices to the Year 2000.

18. Aviation Futures to the Year 2000. FAA.

19. Economic Report of the President. January 1977.

20. Olason and Reynolds: A View of Air Freight Developments in the Next Decade. Boeing Commercial Airplane Company.

21. A Long-Time Forecast of U.S. Waterborne Foreign Trade 1976 - 2000. Maritime Administration, April 1977.

22. Containerized Cargo Statistics, Calendar Year 1974. Maritime Administration, p.3.

23. Cargo Aircraft Requirements 1980 - 2000. CMRS 303A, Lockheed-Georgia Company.

(Section IV)

24. Porton, O.I.M.: Strong, Sure, Scheduled Services - Via Conferences. Container News, January 1976.

25. Serenbetz, Warren L.: Expansion in Domestic Use of Containerization. Container News, January 1976.

26. Macklin, Richard: Detente in the Air Shipping Industry. Cargo Airlift, January 1976.

27. The Air Cargo Market in the United States to 1985. Vols. I and II. Frost and Sullivan, January 1977.

28. Healy, Joseph, Sr.: Quotation in New York Times. August 18, 1974.

29. Gallagher, Patrick ed.: America Goes Intermodal. Handling and Shipping, July 1977.

30. Cook, John C.: Air Freight Breakthrough Lags Behind Predictions. Air Transport World, March 1977.

31. Northwest Airlines - Bumpy Way to the Airfreight Breakthrough. Air Transport World, November 1977.

32. Container Management in an Intermodal Airfreight System. Boeing Brochure, May 1976.

33. Ownership and Use of Containers for Surface Transportation. DOD Instruction No. 4500.37, August 1976.

34. Engineering for Transportability. DOD Directive No. 3224.1, November 1977.

35. Seaboard Is Flying Less, But Enjoying It More. Air Transport World, March 1978.

36. Project INTACT, Intermodal Air Cargo Test Summary Report. Lockheed-Georgia Company, July 1976.

37. Gebhardt, J. Bruch: Where We're At. Cargo Airlift, November 1975.

38. New Boeing Combi Proves Big Success. Journal of Commerce, January 12, 1978.

39. Inventory of American Intermodal Equipment 1977. Maritime Commission, U.S. Department of Commerce, February 1977.

40. Thrasher: Spotted the Trend. Container News, January 1978.

41. Mahoney, John H., Sr.: Intermodal Action - The Challenge of Today. Address to National Conference and Shippers' Dialogue/Containerization Institute, Washington, D.C., October 1974.

42. Morrison, H. R.; and Wright, C. B.: Advanced Cargo Handling Systems. SAE Paper 690633, October 1969.

43. Redding, Robert E.: Remarks Delivered to the Air Cargo Systems Conference, Nashville, Tenn. Reported in Department of Transportation News, August 1973.

44. Impact of Intermodal Containerization on USAF Cargo Airlift. ASD-TR-72-76, August 1972.

45. Aerial Port Container Handling Equipment Requirements and Air Transportability for Intermodal Containers, May 1974.

46. ICS is No. 2 in Boxes and It's Trying Harder. Container News, May 1977.

(Section V)

47. Department of Commerce Census of Transportation, 1972.

48. Standard Method of Estimating Comparative Direct Operating Costs of Turbine Powered Transport Airplanes. Air Transport Association of America, December 1967.

49. Cost of Transporting Freight, Class I and Class II Motor Common Carriers of General Commodities, 1972.

APPENDIX I-A

AIR-SURFACE COMPARISON SURVEY FORMS

AIRPORT SURVEY
Trans World Airlines
Lockheed-Georgia Company

AIRPORT OFFICIAL:		**AIRPORT:**	
Name	______	Name	______
Title	______	City	______
DATE:	______	Country	______

A. GENERAL AIRPORT CHARACTERISTICS

1. What is the total surface area of the airport:

   a. Grounds (excluding buildings)? ______ Units: ______ (Sq. Feet, Sq. Meters)

   b. Buildings. ______ Units: ______ (Sq. Feet, Sq. Meters)

2. What is the total number of passenger gates? ______

3. What is the total number of gates for all-cargo aircraft? ______

4. What year was the airport opened? ______

5. What are the major restrictions on airport cargo operations with respect to:

   a. Saturation (daily/weekly/seasonal peaks in aircraft movement)?

   b. Use of slots (high density traffic allocation)?

   c. Night-time operating restrictions/curfews?

   d. Gate limitations (aircraft size restrictions)?

   e. Noise restrictions (other than curfews)?

6. What are the maximum and minimum number of aircraft movements scheduled per hour under VFR conditions?

Maximum____________________ Minimum____________________

7. With respect to airport accessibility:

a. What is the distance (auto miles) from the city center?

____________________ Units:________________________
(Miles, Kilometers,etc.)

b. How many minutes are required to reach the city center during peak hours?

____________________ During off-peak hours?________________________

c. What long distance or limited access highways provide access to the airport?

8. With respect to airport operating parameters:

a. What is the maximum length/width of runway?

Length_____________ Width_____________ Units:________________________
(Feet, Meters)

b. What is the maximum weight capacity of the runway? ____________ Units:__________
(Pounds, Kilos)

9. General:

a. What is the location of the airport? Longitude______________ Latitude_____________

b. What is the elevation of the airport? ____________ Units:____________________
(Feet, Meters)

c. What is the climate of the area?

(1) Summer temperature range:____________________ Units:____________________
(Fahrenheit, Centigrade)

(2) Winter temperature range:____________________ Units:____________________
(Fahrenheit, Centigrade)

<u>FREIGHT FLOW AND OPERATING CHARACTERISTICS</u> (Data collected: 19_____)

1. Approximately how many tons/tonnes of <u>scheduled</u> cargo are handled annually?____________

2. Approximately how many <u>total</u> tons/tonnes of cargo are handled annually?______________

3 What percentage of the cargo handled is: Domestic?__________% International?__________%

4. How many carriers serve the airport?____

5. With respect to passenger boardings, what are the top ten passenger carriers serving the airport? (Please rank, with "1" representing the carrier with the most passenger boardings).

1) ______________________ 6) ______________________
2) ______________________ 7) ______________________
3) ______________________ 8) ______________________
4) ______________________ 9) ______________________
5) ______________________ 10) ______________________

6. With respect to annual tons of cargo handled, please rank the top ten carriers which offer all-cargo flights.

1) ______________________ 6) ______________________
2) ______________________ 7) ______________________
3) ______________________ 8) ______________________
4) ______________________ 9) ______________________
5) ______________________ 10) ______________________

7. Which carriers have the most mechanized and/or automated cargo handling facilities?

______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ ______________________

8. What is the average number of weekly all-cargo flights which are:

Scheduled? __________ Chartered/Other? __________

9. What is the average number of weekly all-cargo flights on:

747s? __________ 707/DC8s? __________ Other jets? __________ (727,737,DC9, etc.) All other __________

10. What is the average number of passenger flights per month? __________

11. What is the average number of international flights per month?

a. Passenger flights: Scheduled? __________ Chartered/Other? __________

b. All-cargo flights: Scheduled? __________ Chartered/Other? __________

12. What is the ratio of belly cargo to total cargo? Belly/Total = __________ %

13. What is the ratio of unitized (containerized/palletized) cargo to total cargo?

Unitized/Total = _________%

14. What is the ratio of shipper unitized (structural container) to total cargo?

Shipper unitized/Total = _________%

15. What percentage of containerized freight is shipped in 8'x8' containers?_________%

C. CARGO TERMINAL FACILITIES (Data collected: 19____)

1. What is the approximate total surface area of cargo-related:

   a. Ground areas (excluding buildings)? ____________ Units:____________
   (Sq. Feet, Sq. Meters)

   b. Buildings? ____________ Units:____________
   (Sq. Feet, Sq. Meters)

   c. Non-developed areas available for expansion?________ Units:____________
   (Sq. Feet, Sq. Meters)

2. How many cargo-related buildings are located at the airport?____________________

3. How many truck docks are located at the cargo terminal/s?____________________

D. TRAFFIC SERVICING AND TERMINAL COSTS

1. What is the approximate cost of aircraft fuel in your local area?________________
   (Please specify currency and units, i.e., dollars/gallon, etc.)

2. With respect to average costs:

   a. What is the average hourly wage for local cargo warehouse personnel?

   ____________ per hour. Currency units:____________________
   (Dollars, Pounds, Francs, etc.)

   b. What are cargo handling costs per ton?

   ____________ per ton. Currency units:____________________
   (Dollars, Pounds, Francs, etc.)

   c. What are the average terminal construction costs?

   ____________ per square foot/meter. Units:____________________
   (Dollars, Pounds, Francs, etc.)

   d. What are the average terminal leasing costs?

   ____________ per square foot/meter.

2. Average Costs (Continued)

e. What are typical landing fee rates for:

707?____________

747?____________

Currency units:________________________
(Dollars, Pounds, Francs, etc.)

DC8?____________

f. What are the average storage costs in the cargo terminal/s?

________________ per square foot/meter.

Units:____________________
(Sq. Foot, Sq. Meter)

ADDITIONAL COMMENTS:

Thank you for completing this survey. Your assistance is sincerely appreciated.

APPENDIX I-B

AIRPORT SURVEY FORMS

NAME: ____________________
TITLE: ____________________
COMPANY: ____________________
ADDRESS: ____________________
____
____
TELEPHONE: ( ) ____________________
TRANSPORT MODE: ____________________
(Motor, Rail, Sea, Air, Freight Forwarder)

Trans World Airlines
Lockheed-Georgia Company

September 1977

ROUTE: ____________________
COMMODITY: ____________________
____
SHIPMENT DESCRIPTION: ____________________
____
____
____
____
____

	SHIPMENT SIZE		
	Weight = 500 lbs. Volume = cu.ft.	Weight = 3,000 lbs. Volume = cu.ft.	Weight = 20,000 lbs. Volume = cu.ft
I. RATES			
A. Given the above shipment description, please indicate the applicable mode transport tariff rate for shipments of each sample size.	$______	$______	$______
B. Would container/truckload rates be available for a shipment of this size?	Yes ____ No ____	Yes ____ No ____	Yes ____ No ____
C. If so, what would the tariff rate be?	$______	$______	$______
D. Does this tariff (for a shipment of this size) include door-to-door delivery?	Yes ____ No ____	Yes ____ No ____	Yes ____ No ____
E. If door-to-door delivery is not included in the tariff, please specify Pick-up and Delivery charges (for weekday service).	$______	$______	$______
F. Please describe and estimate any additional charges which would apply between origin and destination on this route.			
II. SERVICE			
A. What is your estimate of the actual mode transport time for a shipment on this route.	____ day/s	____ day/s	____ day/s
B. What is your estimate of total time for Pick-up and Delivery of this shipment?	____ day/s	____ day/s	____ day/s

	SHIPMENT SIZE		
	Weight = 500 lbs. Density = cu.ft.	Weight = 3,000 lbs. Density = cu.ft.	Weight = 20,000 lbs. Density = cu.ft.
II. SERVICE			
C. Is it likely that containers will be used for this shipment? If so, please identify and describe type:	Yes ____ No ____	Yes ____ No ____	Yes ____ No ____
D. If a Pick-up & Delivery service is to be used, who will provide the service? (Indicate one: shipper, freight forwarder, independent trucker, carrier cartage agent, broker, consolidator)			
E. (International routes only). What is your estimate of the time required for Customs clearance of this shipment?	12 hrs or less ____ 13-23 hours ____ 1-2 days ____ 3-4 days ____ 5 or more days ____	12 hrs or less ____ 13-23 hours ____ 1-2 days ____ 3-4 days ____ 5 or more days ____	12 hrs or less ____ 13-23 hours ____ 1-2 days ____ 3-4 days ____ 5 or more days ____
F. What is your frequency of scheduled service on this route? (Freight forwarders omit this question).	____trips/week	____trips/week	____trips/week
G. What is the average number of shipments processed on this route per week?	____shipments per week	____shipments per week	____shipments per week
H. What is the average number of pounds shipped on this route (in your operation) per week?	____pounds/week	____pounds/week	____pounds/week

I. What is your claims ratio, i.e., Overage, Shortage and Damage claims expressed as a percent of revenue? ______%

J. What are the main causes of delay encountered on this route?

APPENDIX I-C

EXEMPTION DOCUMENTS FOR BOSTON
CURFEW HEARINGS - 1978

THE FLYING TIGER LINE INC.
7401 WORLD WAY WEST
INTERNATIONAL AIRPORT
LOS ANGELES, CALIFORNIA 90009
(213) 646-5145 • 646-6131

CARL SWARTZ
ASSISTANT GENERAL ATTORNEY

December 28, 1977

Ms. Donna Berman
Massachusetts Port Authority
Logan International Airport
Boston, Massachusetts

Re: Petition for Exemption--Flying Tiger Flight 243

Dear Ms. Berman:

Pursuant to Part E, Article III, Paragraph B.4 of the Rules and Regulations for Logan International Airport, Flying Tiger respectfully requests the attached Petition for Exemption for all-cargo Flight 243 be granted for the maximum two-year period. Flight 243 departs Logan International Airport at 0030 hours, Tuesday through Sunday.

As the attached material sets forth, Flying Tiger would be severely impacted in the event Flight 243 was required to be re-scheduled into the earlier evening hours. The present departure time, which offers as its primary advantage a highly desirable late-night "closing" for shipments outbound from Boston, is conveniently scheduled for connecting service over Chicago on other Flying Tiger flights in order to provide overnight service to most major U.S. cities. The final destination of Flight 243 is Los Angeles with an arrival of 0600 hours which provides even the most distant West Coast customers with shipments ready for pick-up prior to the next work day. In addition, Flight 243 connects over Chicago to Flying Tiger's prime time daily international departure at 0320 hours which in turn provides prompt service for the Boston shipper to the major cities in the Far East.

Flight 243 has operated at Logan International Airport between the scheduled times of 0030 and 0100 hours since the Flight's introduction on September 30, 1968. The flight has operated without interruption since that time on Tuesday through Saturday with the Sunday service added in July, 1973 in response to demand from Boston shippers.

We look forward to your favorable consideration of the attached Petition and the opportunity to provide you with whatever further information you may need. Any questions relating to the Petition should be directed to the undersigned.

Very truly yours,

Carl Swartz

Carl Swartz

CS/sw
Attachment

Section I

Fleet Composition

A. State the composition of your current all-cargo fleet.

AIRCRAFT TYPE AND SERIES	NO. IN FLEET	PAY LOAD	PART 36 yes	PART 36 no
DC-8-55	1			no
DC-8-61	2			no
DC-8-63	14			no
B-747	5		yes	

B. Describe all projected changes in all-cargo fleet composition. Include current or anticipated new aircraft orders, leasing arrangements and retrofit or retirement schedule of aircraft currently in fleet.

1. The one DC-8-55 aircraft is presently on lease to Flying Tiger and is due to return to the lessor on January 31, 1978.

2. One DC-8-63 presently on lease from Flying Tiger will be returne to Flying Tiger in September, 1978.

3. One B-747 presently in the Flying Tiger fleet will be leased commencing January 8, 1978 through August, 1979. An additional B-747 presently on lease from Flying Tiger will be returned to Flying Tiger on June 29, 1978.

4. Based upon the recent Federal deregulation of air cargo, Flying Tiger anticipates being granted authority to provide all-cargo service to all 50 states. Because of the forecasted requirement for additional aircraft, various acquisition alternatives are

(continued on attached page)

C. Describe efforts taken to provide the service by an aircraft certificated in accordance.

The Flying Tiger service pattern at Boston, as reflected in the Implementation Plan submitted on August 31, 1977, defines in greater detail the efforts taken to provide Flight 243 service by an aircraft certificated to Part 36.

As shown by Attachment 1, Flight 243 presently carries approx imately 75,000 pounds of freight nightly on the Boston to Chicago segment. This figure expands to approximately 80,000 pounds per night when U.S. and foreign mail and express shipments are include

The November, 1977 performance records indicate that Flight 243 operated 24 times between Boston and Chicago at a load factor of 79.9%. This load factor is based upon assignment of the DC-8 freighters presently utilized for the service. The 79.9% compares favorably to the domestic DC-8 break-even load factor of 61% based upon Flying Tiger operations for the year ending June 30, 1977.

(continued on attached page)

SECTION I (continued)

Fleet Composition

9. (No. 4 continued)

are being studied. At present, however, there are no firm acquisition plans including either new aircraft orders or leasing arrangements other than as set forth above.

5. Flying Tiger is presently studying alternatives relating to compliance with the Federal Noise Abatement Regulations issued December 23, 1976. These alternatives include retrofitting the DC-8 aircraft (the non-Part 36 aircraft in the Flying Tiger fleet) with sound absorbent material, substituting Part 36 engines for the existing DC-8 engines, and replacing the DC-8 aircraft with Part 36 aircraft. The Flying Tiger analysis has been in progress for over one and one-half years with the final decision awaiting action by the U.S. Congress on proposed financing assistance.

* * * * * *

C. (continued)

By comparison, substitution of the only Part 36 Flying Tiger aircraft, the B-747, would result in the Flight operating at a load factor of 33%. The resultant operation would be significantly below the domestic B-747 break-even load factor of 56% which is based upon Flying Tiger operations for the year ending June 30, 197 In addition, such substitution does not take into account the late afternoon arrival of the aircraft which becomes the outbound Flight 243. The typical loads operating on the inbound leg are less by comparison than the outbound Flight 243.

Further, the Boston substitution of a B-747 for DC-8 does not take into account the system-wide impact. The substitution would result in a critical reduction in lift capability and profitability in Flying Tiger's Asian operations. Flying Tiger B-747's generally operate at nearly full capacity in the eastbound direction between Asia and the United States. Any reduction in B-747 availability in this market therefore, in order to provide Part 36 B-747 service at Boston, would be an extremely costly and undesirable alternative.

Section II

Economic Information

Please describe the economic importance of the service to the New England region or a part therof.

Amount of Freight Carried on Flight 243

As discussed in Section I.C above, Flight 243 presently carries a total of approximately 80,000 pounds per night including freight, U.S. and foreign mail, and express shipments. A more detailed description of the November, 1977 carriage of Flight 243 is contained in Attachment 1

Attachment 2 shows that on average, approximately 130,000 pounds of freight (exclusive of mail and express shipments) originated daily at Boston during 1976 for carriage on Flying Tiger to domestic destinations.*

Attachment 3 shows that a growing volume of international freight, averaging approximately 15,000 per day during 1976, also originated at Boston for carriage on Flying Tiger.

The combination of the domestic and international cargo originated daily at Boston is summarized in Attachment 4. Approximately 145,000 pounds were originated daily at Boston destined for domestic and international markets during 1976. This freight is carried by the combination of Flight 243 and a later 1015 daily departure.

Type of Freight

Shipments on Flight 243 generally fall into four broad categories requiring next-day delivery. The categories include:

1. U.S. mail--Flying Tiger handles mail from the entire New England region. The mail is trucked to Boston and consolidated for distribution throughout the U.S. and to overseas destinations.
2. Regular shipments--A number of factors contribute to the choice of air for the distribution of products produced and manufactured in the Boston and greater New England area. The primary stimuli for shipment by air include: the size and value of the shipment; the requirement to satisfy a production or order cycle; the desi to minimize inventory carrying cost; the need for reliability in transfer; and, the requirement to maintain a competitive distribution posture relative to suppliers and manufacturers in other parts of the U.S.
3. Perishables--Flying Tiger provides major carriage for perishables such as fruits, vegetables, sea food, advertising material, live animals, newspapers, and radioactive materials. As one example, Flying Tiger ships more than one million pounds of tuna to Japan per year.

(continued on attached page)

---

* 1976 is the most recent year for which complete year statistics are available.

SECTION II (continued)

Economic Information

4. Emergency Shipments--Flying Tiger handles a wide variety of Boston and greater New England shipments categorized by the shipper as emergency shipments. The items are such that their lack of availability would result in major production line shut-downs, severe out-of-stock situations, etc.

Origin/Destination of Shipments

The geographic origin of shipments carried on Flight 243 is the greater New England region. This region encompasses from Presque Isle, Maine on the north to New Haven, Connecticut on the south and North Adams, Massachusetts to the west. Shipments received are destined for markets in the midwest which are served through Flying Tiger operations in Cleveland and Detroit; for markets on the West Coast which are served through Flying Tiger operations in Los Angeles, San Francisco and Seattle; and for markets in Asia which are served through Flying Tiger operations in Japan, the Philippines, Hong Kong, Korea, Taiwan and Singapore.

Attachment 5 is indicative of the New England shippers and communities served by Flight 243. The list is based upon shippers using Flight 243 during 1977.

Alternative Shipping Methods

As reflected in Attachment 2, approximately 95% of the 1976 domestic tonnage outbound from Boston on Flying Tiger was carried to the combination of Chicago, Los Angeles, San Francisco, and Seattle. These cities are well beyond overnight shipping distance from Boston by surface mode. Further, as illustrated by Attachment 3, more than 97% of the international tonnage was carried to Hong Kong, Seoul, Taipei and Tokyo. As there is insufficient outbound airlift capacity available throughout the night hours, the sole alternative for the preponderance of freight carried by Flight 243 would be air 6-10 hours later in the day.

In light of the type of cargo transported by Flight 243 including U.S. mail, perishables, and emergency shipments, there is no satisfactory alternative in the event Flight 243 is not permitted to continue under its present schedule.

Effects of Cancellation

The result of transfer of Flight 243 cargo to alternative shipping methods--either air on later flights or surface--can best be determined by examining the categories of cargo defined above. For example, the delivery of U.S. mail would be delayed an estimated full day, New England manufacturers would be placed at a competitive disadvantage in comparison to those manufacturers and suppliers from other regions who are able to utilize optimum flight times; perishables would be damaged which in certain instances (e.g. newspapers) would represent irreparable loss; and emergency shipments vital to personal as well as economic health and welfare would be delayed.

For a more detailed and comprehensive analysis of the effects of cancellation of all-cargo night flights such as Flight 243 on the New England economy, I would respectfully direct the attention of Massport authorities to the following:

1. "The Effects of Limiting Night Flights at Logan Airport", Massachusetts Port Authority, August, 1976.
2. "Airfreight's Economic Impact on Boston", Presentation by R.H. Steiner, Vice President, Marketing, The Flying Tiger Line Inc., before the Boston Committee on Nighttime Noise Limitations, July 21, 1976.

Section III

Scheduling Information

Describe the reasons that the flight cannot reasonably be scheduled outside of the restricted hours.

Market Factors Affecting the Scheduling/Cargo-Handling Limitations

The four general categories of cargo described in Section II represent approximately 90% of the volume handled by Flying Tiger at Boston for Flight 243. The bulk of the shipments are received at the Flying Tiger Terminal after 2100 hours EST. Because of the substantial load factor at which Flight 243 operates, a minimum of two and one-half hours is required to prepare the freight for carriage and load the aircraft. Even a minimal roll-back in the departure time would adversely effect an estimated 25-30% of the mail and an estimated 40% of the other categories of freight. The impact of such a loss in cargo would be to reduce the tonnage carried by Flight 243 to approximately 49,000 pounds resulting in a load factor of 49%, well below the DC-8 break-even load factor for Flying Tiger domestic operations of 61%. A minimal roll-back would therefore destroy the economic viability of Flight 243.

As discussed above, the rescheduling of Flight 243 to a non-curfew time would force shippers into an alternative selection process. The result would be that New England producers and manufacturers would incur higher costs because of their reliance on alternative shipping methods. In addition, shippers would suffer a deterioration in their competitive posture because of their inability to meet competition throughout the country which is able to rely upon air transportation operating at optimum flight times.

Effect on Other Flying Tiger Services of Rescheduling Flight 243 to a Non-Restricted Time Period

Flight 243 originates in Boston and is operated with the DC-8 equipment which arrives at Boston as Flight 144 at 1755 hours. The critical concern in rescheduling Flight 243 to a non-restricted time is foreclosing the Flight to the shipper. The Flight 243 aircraft is available for an earlier departure but, as set forth above, such a roll-back would result in a loss in the economic viability of the operation. Simply stated, Flight 243 is scheduled in response to the demands of the market and the requirement of the shippers for a late-night operation.

The economic viability consideration can also be treated in terms of aircraft utilization. An earlier departure from Boston, with a load below the break-even load factor, results first in the aircraft being under-utilized between Boston and Chicago, and second, in the aircraft nonetheless being held at Chicago until its presently scheduled departure time of 0340. Flight 243, as it presently operates, is scheduled to receive connecting westbound cargo over Chicago from Chicago, Cleveland, Philadelphia, New York, Detroit, and Syracuse (as well as from the satellite cities served by those major centers), which is destined for Los Angeles on the continuing Flight 243. As the Chicago/Los Angeles leg of Flight 243 is timed to receive the Chicago inbound cargo from the above cities, the bulk of which arrives at Chicago between 0200 and 0240, Flight 243 would in no event be scheduled to depart Chicago earlier than 0340. An earlier Boston departure would therefore require Flight 243 to remain on the ground unnecessarily long at Chicago, to the detriment of the Boston shipper foreclosed from using Flight 243 because of the roll-back in the departure time.

Description of Freight Categories for Which Overnight Service is Require

Airfreight is a value service which is provided at a premium price significantly above the shipping costs associated with surface modes. The shipper who selects airfreight does so because of stringent time, handling, safety, and reliability requirements. The categories of freig therefore for which overnight service by Flight 243 is, or may be, required correspond precisely to those categories set forth in Section II above. It is critical to the U.S. Postal Service that U.S. mail be handled in timely and reliable fashion; it is essential to the shipper of perishables that these items be handled promptly and properly; and, it is important to the shipper of emergency shipments as well as more conventional cargo that these goods be transported in a timely and reliable manner. In sum, virtually all cargo carried by Flight 243 is cargo for which overnight service is imperative.

Attachment 1

AVERAGE ON-BOARD LOAD BOSTON-CHICAGO SEGMENT, FLIGHT FTL 243
NOVEMBER 1977

	TRAFFIC CATEGORY	
ITEM	REGULAR FREIGHT	TOTAL
Revenue ton miles	774,133	831,972
Boston-Chicago nonstop mileage	864	864
Revenue tons	896.0	962.9
Departures	24	24
Revenue tons per flight	37.3	40.1
Revenue pounds per flight	74,666	80,244
Load factor	74.3%	79.9%

Source: Company Records

ORIGINAL PAGE IS
OF POOR QUALITY

Attachment 2

HISTORY OF FTL DOMESTIC FREIGHT TRAFFIC ORIGINATED AT LOGAN AIRPORT
1976

Boston Domestic Market To:

ITEM	Chicago	Los Angeles	San Francisco	Seattle	T
Calendar Year 1976					
Number of shipments	13,799	11,972	9,281	5,126	45,
Pounds (000)	7,096.0	12,268.5	7,983.9	2,897.5	32,
Revenue ($000)	1,426.3	3,984.0	2,806.5	1,000.8	9,7
Daily average pounds	28,384.0	49,074.0	31,935.6	11,590.0	130,
Revenue per pound ($)	0.201	0.325	0.352	0.345	0.3
Yield (revenue per ton mile) ($)	0.4637	0.2487	0.2600	0.2768	0.2

Source: Company Records

Attachment 3

HISTORY OF FTL INTERNATIONAL FREIGHT TRAFFIC ORIGINATED AT LOGAN AIRPORT
1976

Boston International Market To:

ITEM	Hong Kong	Seoul	Taipei	Tokyo	Total
Calendar Year 1976					
Number of shipments	1,604	520	1,389	1,931	5,785
Pounds (000)	391.9	92.4	232.8	2,300.8	3,121.7
Revenue ($000)	477.0	119.8	330.1	2,029.1	3,088.3
Daily average pounds	1,822.8	429.8	1,082.8	10,701.4	14,519.5
Revenue per pound ($)	1.217	1.296	1.418	0.882	0.989
Yield (revenue per ton mile) ($)	0.3056	0.3802	0.3673	0.2622	0.2828

Source: Company Records

Attachment 4

SUMMARY OF FTL FREIGHT TRAFFIC ORIGINATED AT LOGAN AIRPORT
1976

ITEM	DOMESTIC AND INTERNATIONAL TOTAL
Calendar Year 1976	
Number of shipments	51, 334
Pounds (000)	35, 715. 5
Revenue ($000)	12, 885. 5
Daily average pounds	144, 894. 7
Revenue per pound ($)	0. 361
Yield (revenue per ton mile) ($)	0. 2812

Source: Company Records

Attachment 5

1977 Year-to-Date

Examples of New England Communities/Shippers Affected:

Origin Community	Shipper	Destination
Milford, CT	Bic Pen	ORD, LAX
Southboro, MA	Data General	HKG, LAX, SEA, SFO
Framingham, MA	Data General Int'l	HKG, LAX, SEA, SFO
Taunton, MA	Swank	PDX, SEA
Indian Orchard, MA	Westover Mills	LAX
Providence, RI	Moran Co.	HKG, SFO, TYO, ETC.
New Bedford, MA	Acushnet	DTW
Pawtucket, RI	American Insulated Wire	SFO
Webster, MA	Angelo Fabrics	LAX
Worcester, MA	Astro Pharmaceuticals	LAX
Leominster, MA	Banner Mold & Die	LAX
Woonsocket, RI	Burgro	LAX
New Bedford, MA	Cliftex	ORD
New Bedford, MA	Cornell Dubilier	SFO, SEA
Westerly, RI	Darlington Fabrics	LAX
Fairhaven, MA	Golden Eye Seafood	LAX, SFO
Clinton, MA	ITT Wire & Cable	LAX, ORD
Cranton, RI	Jewelers Shippers Assn.	LAX, ORD, SFO
Leominster, MA	Mohawk Wire & Cable	LAX, ORD
Worcester, MA	Norton Co.	LAX
Woonsocket, RI	Ocean State Finishing	LAX
Sandwich, MA	Seafood Distributors	LAX
Gardner, MA	Simplex Time Recorder	SFO, SEA
Attleboro, MA	Texas Instruments	SFO, ORD, LAX
Framingham, MA	Dennison, Mfg.	LAX, ORD, SFO
Canton, MA	Plymouth Rubber	LAX, ORD
Plymouth, MA	Superior Pet Products	LAX
Wilmington, MA	Analog Devices	HKG, MNL, TPE
Wilmington, MA	Avco Corp. Systems Div.	LAX
Gloucester, MA	Boat Shop	ORD
Wilmington, MA	Charles River Breed Labs.	ORD
Maynard, MA	Digital Equipment	LAX, ORD, PDX, SEA, SF
Lawrence, MA	Horne & Sons	LAX
N. Billerica, MA	Nen Pharmaceuticals	LAX
N. Billerica, MA	New England Nuclear Corp.	TPE
Newport, VT	Newport Plastics	ORD, SEA
Lawrence, MA	Western Electric	LAX, ORD
Calais, ME	Fenderson, Inc.	TYO
N. Andover, MA	Alco Electronic	TYO
Tenants Harbor, ME	Atwood Bros.	LAX
Lawrence, MA	Bolta Products	LAX
Hudson, NH	Centronics Data Computer	LAX, SEA
Dover, NH	Davidson Rubber Co.	SFO
Farmington, NH	Davidson Rubber Co.	SFO

Attachment 5 (con't)

Origin Community	Shipper	Destination
Rock Port, ME	Graffam Bros.	ORD, LAX, SFO
W. Swanzey, NH	Homestead Mill	LAX, SEA, SFO
Lincoln, ME	Lincoln Pulp & Paper	PDX
Spruce Head, ME	Maine Coast Seafoods	LAX, ORD, SFO
Manchester, NH	Raytheon Co.	LAX, SEA, SFO
Nashua, NH	Sanders Associates	LAX, SEA, SFO
Seabrook NH	U. S. M. Corp.	ORD, SFO
E. Hartford, CT	Pratt & Whitney	LAX, SEA
Chicopee, ME	General Instruments	TPE
Wallingford, CT	Ulbrich Corp.	LAX, ORD, SEA, SFO
Milford, CT	Welling International	ORD

Source: Company Records

TRANS WORLD AIRLINES

January 24, 1978

A1C-16

General

TWA currently operates a fleet of ten Boeing 707-300C aircraft in scheduled all-cargo service. Nine aircraft are used primarily to provide "prime time" overnight freighter service within the United States, while the tenth is used principally for transatlantic operations between the U.S. and Europe. Each aircraft has a nominal (weight) payload of approximately 75,000 pounds; none currently comply with the provisions of FAR Part 36.

Since TWA has been and intends to continue to be a major all-cargo operator, the company is currently evaluating replacements for its 707 cargo aircraft, in order to eliminate aircraft which do not comply with Part 36 by 1985. Although any aircraft selected to replace the 707 fleet will comply with Part 36, the type is not yet known; and, in any case, the likelihood of obtaining replacement equipment within the next several years is low due to the economic conditions being experienced by TWA. Thus, it should be apparent that there are no all-cargo aircraft, either currently or immediately contemplated, which could be used to provide the service in question.

Economics

TWA has operated Flight 601 on its Boston/Chicago/Los Angeles routing continuously since April 1, 1977, departing at approximately 12:45 AM. From August 1, 1976 to March 31, 1977, service was provided via Kennedy to Los Angeles, departing at 12:20 AM. Prior to that, TWA operated other flights from Boston to west coast destinations via either Philadelphia or Kennedy.

The schedules operated prior to April 1, 1977 were unsatisfactory and produced unprofitable results for two reasons: early, noncompetitive departure times, and subordination of Boston traffic to other cities such as Philadelphia and New York. Moving to the later departure time, which is directly competitive with the other two freighter operations which depart between 12:30 and 1:00 AM, coupled with non-stop service to Chicago has enabled TWA to vastly improve the performance of their flight (Exhibit I) to the point where profitability will be achieved in the near future, based on current trends. In recent months the flight has operated at about 55% of its <u>weight</u> carrying capacity, with approximately 65% of the available <u>space</u> being occupied on each trip.

Cargo carried on this flight consists of U.S. mail, representing approximately 8 - 10% of this total load, the remainder being freight of various commodities. Approximately 5% of the freight traffic is physically perishable (e.g. seafood) while the rest is of an emergency nature or economically perishable; i.e. items which tend to diminish in value if they cannot be sold quickly, due to factors such as a loss in timeliness in the case of a periodical, or changes in buying habits with regard to fashion items and wearing apparel.

Some idea of the emergency/economically perishable nature of these goods can be gained by considering the fact that traffic on this flight is charged essentially a premium rate, much higher than that for surface carriage, when, in fact, lower air rates are available at other times of day. TWA is well aware of this differential, inasmuch as, during 1977, we heavily promoted daytime air carriage at essentially surface rates to precisely the same cities as those served by Flight 601. The results of this effort indicate that not only was traffic not diverted from Flight 601 to take advantage of the lower rates, but the opposite occurred -- traffic on Flight 601 increased during the period of this promotion. This tends to indicate that service -- including the late night timing of the departure -- is of the utmost importance to this type of traffic, and is even more important than price.

The importance of this flight to the New England economy can be seen from the wide variety of cities from which freight originates (Exhibit 2). In brief,

A1C-18

this listing encompasses the area from Hartford, Connecticut to Portland, Maine, including numerous points in Massachusetts, Rhode Island, New Hampshire and Connecticut.

Traffic from these numerous points is afforded overnight "next morning" service to the key cities of Chicago, Milwaukee, Los Angeles and San Francisco, as well as expedited service to many other points. Similar service is also available to these points from areas contiguous to the Boston region including Hartford-Springfield and New York City; service of lesser desirability is also available on daytime passenger flights, as previously mentioned. Exhibit III, attached, lists some of the major shippers now using this service.

Were the service provided by Flight 601 not provided, it is quite likely that traffic desiring overnight service would avail itself of the similar services available at other nearby cities, as much as would be operationally feasible. It seems doubtful that the traffic now handled on Flight 601 could be accommodated on any single flight, inasmuch as Flight 601 currently operates with about 65% space utilization, and available public data indicate that neither of the two other flights with which Flight 601 competes has sufficient capacity to accommodate this traffic. Thus, it seems likely that not all traffic currently utilizing this type of prime service from Boston to western points would be able to continue to do so in the absence of Flight 601. Those shipments which could no longer move in this manner represent a serious threat to the economy of the New England area, since they would be more vulnerable to competition from other areas which had overnight service.

Aside from the disadvantage of being known elsewhere as an area that "you can't get it here from there" the New England economy would suffer more directly as a result of the loss of all jobs directly associated with this flight, since TWA would be forced to move the service elsewhere. In addition, it is probable that there would be a secondary job loss among the truckers/forwarders, etc. associated with this flight.

Rescheduling

It might reasonably be asked why Flight 601 could not be scheduled outside the restricted hours. There are several basic problems inherent in this approach, including market factors, handling limitations and technical scheduling difficulties.

Market factors have to do with the inability of shippers to consolidate their daily production prior to the late evening hours, particularly if they are in areas distant from Logan Airport. As previously indicated, if overnight service is not available to their products they may be forced to revert to slower surface carriage, which carries with it all the potential for loss of competitiveness in distant markets or, in the case of many perishable products, results in the elimination of those markets immediately.

Handling limitations refers not only to the fact that traffic is generally not available from shippers until late in the evening, but also that approximately 80% of the traffic on this flight is from forwarders/consolidators. We have been informed by a forwarder that 50% of the traffic destined for this flight arrives at its dock between 9:00 and 10:30 PM. Even with the present schedule, the forwarder finds it difficult to meet the existing acceptance times -- 90 minutes for most freight, 45 minutes for full container traffic -- required by TWA to safely load and dispatch the flight on time. This situation results from the forwarder's customers requesting late afternoon pick-ups so as to maximize deliveries of the day's production; this causes the forwarder to have little time to consolidate the traffic for tender to TWA even under the current schedule. Other forwarders operate under similar circumstances, for similar reasons; the problems described are compounded when the shipper's plant is some distance from the airport and/or consolidation facility.

In addition to the above, technical scheduling requirements make the rescheduling of this flight to an earlier time period difficult, if not impossible. In the first place, the flight could not be rescheduled on its Chicago/Los Angeles segment since this would cause traffic on that sector to decline, as well as disrupting important connections. Thus, the total Boston/Los Angeles transit time would be significantly increased, together with flight crew costs; it is possible that this change would also disrupt flight crew schedule patterns to the point where additional crews would be required, eroding the economics of Flight 601 and making profitability even more difficult to achieve. In addition, operation of this flight during an earlier time period would result in greater co-mingling with passenger operations, both on the ground and in the air. On the ground this would tend to increase airport congestion and manpower costs; in the air, increased flying times and, consequently, greater fuel consumption could result.

Summary

The granting of an exemption for Flight 601 would:

- Continue to aid the New England economy.
- Retain jobs in the Boston area
- Allow TWA, a major Boston employer, to continue to strengthen the economics of its New England operations.

The proposed relief is of a limited and fixed nature -- one flight five days per week which provides unique services not provided by flights operating outside the restricted hours. We believe that it is in the best interests of the entire community to grant the exemption as requested.

EXHIBIT I

TRAFFIC INCREASE RESULTING FROM FLIGHT 601 SCHEDULE CHANGE APRIL 1, 1977

Period	Pounds Boarded
January - March 1977 (Prior to Change)	1,424,529
October - December 1977 (After Change)	2,042,345
Net Increase/(Decrease)	617,816
Percent Increase/(Decrease)	43.4%

EXHIBIT II

Shipment Origins: Massachusetts

Haverhill, Lawrence, Lowell, Worcester, Gardner, Fitchburg, Springfield, Holyoke, Boston, Taunton, Brockton, Newton, Marlborough, Northboro, Salem, Swampscott, Wakefield, Woburn, Billerica, Wilmington, New Bedford, Quincy, Cambridge, Milford, Acton, Andover, Stoneham, Melrose, Sudbury, Waltham, Framingham, Needham, Lynn, Fall River, Foxboro, Attleboro.

Shipment Origins: New Hampshire

Salem, Hudson, Nashua, Manchester.

Shipment Origins: Rhode Island

Providence.

Shipment Origins: Connecticut

Hartford.

Shipment Origins: Maine

Portland.

EXHIBIT III

Primary Airport Destinations Served by Flight

(Chicago, Los Angeles, San Francisco, Milwaukee)

Major Shippers: Golden Eye, Graffam Brothers, Maine Coast, Fresh Water, Shulman Air Freight, Profit By Air, EuroAmerican Air Freight, Amerford Air Cargo, Emery Air Freight, ABC Air Freight, Bay State, Bor Air, Novo Air Freight, Pilot Air Freight, W.T.C., Hines & Smart, Burlington Northern Air Freight, Mayflower Seafood, C. F. Airfreight, AEI/Wings & Wheels, Associated Airfreight, Air Freight Forwarding, Circle Airfreight.

ORIGINAL PAGE IS
OF POOR QUALITY

GEORGE E. CLEARY
LEO GOTTLIEB
COUNSEL

[illegible]
[illegible]
LYMAN M. TONDEL, JR.
JAMES B. JOHNSON, JR.
JOHN J. B. SHEA
JEROME E. HYMAN
JOSEPH MORGAN
EDMUND H. KERR
MARK W. FRAWLEY, JR.
GEORGE DeSIPIO
JAMES W. LAMBERTON
ANDRE W. G. NEWBURG
JAMES C. BLAIR
WALTER B. ROTHSCHILD
RICHARD W. HULBERT
RICHARD C. PUGH
GEORGE WEISZ
THOMAS H. HAGOORT
ELLIOTT MANNING
NED B. STILES
SYDNEY M. CONE, III
ALAN APPELBAUM
EDWIN B. M. [illegible]
STEPHEN L. [illegible]
PETER S. PAINE, JR.
ANTHONY C. BOSCH
ROGER W. THOMAS
[illegible] B. MORGAN
CHARLES M. NATHAN
GEORGE J. GRUMBACH, JR.
PETER KARASZ
LOUIS FAHN
MARK A. WALKER
LESLIE B. SAMUELS
ALLAN G. SPERLING
PETER H. DARROW
JAMES F. MUNSELL
SANDRA S. WEIKSNER
EVAN A. DAVIS

RETIRED PARTNERS
ROBERT W. HALES
WILLIAM E. LYNCH

CLEARY, GOTTLIEB, STEEN & HAMILTON
ONE STATE STREET PLAZA
NEW YORK, N.Y. 10004

(212) 344-0600

CABLE: CLEARGOLAW
TELEX: WU 128244
RCA 235438

GEORGE W. BALL
COUNSEL

1250 CONNECTICUT AVENUE, N.W.
WASHINGTON, D.C. 20036
TWX [illegible]

ROBERT C. BARNARD
FRED D. TURNAGE
R. MICHAEL DUNCAN
DONALD L. MORGAN
CHARLES D. MAHAFFIE, JR.
J. EUGENE MARANS
DOUGLAS E. KLIEVER
DANIEL B. SILVER
KENNETH L. BACHMAN, JR.
CHARLES F. LETTOW
RICHARD DeC. HINDS
WASHINGTON PARTNERS

41, AVENUE DE FRIEDLAND
75008 PARIS, FRANCE
TELEX 650081

RICHARD H. MOORE
CLAUDE C. KELLY, JR.
RESIDENT PARTNERS

RUE DE LA LOI 23, BTE 5
1040 BRUSSELS, BELGIUM
TELEX 22036

RICHARD B. WEBSTER
WALTER W. OBERREIT
DONALD L. HOLLEY
GEORGE M. COHEN
RESIDENT PARTNERS

WINCHESTER HOUSE
77 LONDON WALL
LONDON EC2N 1DA, ENGLAND
TELEX: 887659

MANLEY O. HUDSON, JR.
J. SPEED CARROLL
RESIDENT PARTNERS

January 27, 1978

Mr. John Grimes
TWA
605 Third Avenue
44th Floor
New York, New York 10016

Re: Massport

Dear John:

Pursuant to our conversation this afternoon, I am enclosing a copy of the petition for exemption filed by American Airlines. I understand that you have copies of Flying Tiger's petition as well as, of course, your own.

Sincerely,

George J. Grumbach, Jr.

Enclosure

RECEIVED
JAN 30 1978

MASSACHUSETTS PORT AUTHORITY

Re: Noise Abatement Docket No. 1977-4
Petition of American Airlines, Inc.

PLEASE TAKE NOTICE that on September 26, 1976 the Authority received the attached correspondence from American Airlines withdrawing its pending petition for exemption of its flight 855 for 1977 and substituting a new petition for 1978. See Exhibit 1.

Accordingly, the petition of American Airlines, Inc. (Noise Abatement Docket No. 1977-4) is dismissed and a new docket has been instituted of which the customary notice is attached. See Exhibit 2.

MASSACHUSETTS PORT AUTHORITY

By: ______________________
Executive Director

AmericanAirlines Freight System

September 22, 1977

Mr. David W. Davis
Executive Director
Massachusetts Port Authority
99 High Street
Boston, Massachusetts 02110

Dear Mr. Davis:

Attached is a "Petition for Exemption" for American Airlines all-cargo Flight 855.

Flight 855 is scheduled to depart at 0055, which is outside the restricted hours of 0100 through 0600. However, as the time required to push-out the aircraft and taxi to the runway normally requires in excess of five minutes, actual takeoff cannot be achieved until after 0100.

In order to avoid these post 0100 hours takeoffs, we have rescheduled flight 855 for the second time back to 0045 hours. This change will become effective on November 1, 1977. Consequently, we will have to reschedule flight 845 from its present departure time of 11:45PM back to 11:35PM. This is made necessary in order to maintain the time separation between these two flights. (This is explained further in Attachment C to the PETITION FOR EXEMPTION). This change precludes the necessity for American Airlines Inc. to file a PETITION FOR EXEMPTION to the 0100 hours deadline imposed in your NOISE ABATEMENT RULES.

However, we are taking this opportunity to file a PETITION FOR EXEMPTION to the midnight deadline imposed in your NOISE ABATEMENT RULES effective January 1, 1978.

This letter and the attached document are submitted subject to the reservation of rights contained in a letter dated February 16, 1977 to you from American Airlines Legal Department.

Very truly yours,

R. H. Phillips

R. H. Phillips
General Manager
Boston

RHP/tas

cc: Douglas B. MacDonald, Chief Legal Counsel, Massport,
99 High Street, Boston, Mass. 02110

PETITION FOR EXEMPTION

- All-Cargo Aircraft Flights -

TO: Massachusetts Port Authority
99 High Street
Boston, Massachusetts 02110

American Airlines, Inc., hereby petitions
(Corporate Name of Aircraft Operator)
the Massachusetts Port Authority for exemption of the following all-cargo aircraft flight from the Late Night Aircraft Restriction in Part E, Article III of the Authority's Airports Rules and Regulations for Logan International Airport. This flight, as identified below, was in scheduled service as of December 16, 1976.

Flight Number	Scheduled Arrival Time	Scheduled Departure Time	Weekly Frequency	Aircraft Type and Series
855	0908	0045 (eff. 11/1/77)	5 (Ex Sun & Mon)	707 Freighte

To justify the need for this exemption and to provide the basis for an informed judgment on its merits, petitioner provides the following supporting documentation:

1. State the operator's current all-cargo aircraft fleet composition by numbers of aircraft of each type and series and whether or not each is certificated in accordance with FAR Part 36.

   747 - #6[illegible]2, 673, 675

   707 - #[illegible], 556, 563, 564, 565, 566, 567, 568, 569

2. State the changes in all-cargo fleet composition forecast by the operator to include current or anticipated new aircraft orders, aircraft leasing projections, and forecast retrofit and/or retirement schedule of aircraft currently in the fleet.

Our third 747 freighter was placed in service on March 21, 1977.

Beginning in September, 1977, all 747's in the AA fleet will be retrofitted to meet FAR 36. Completion of this program will take four months.

At this time, we have no new freighter aircraft on order.

3. State the name and position of the person preparing this petition and of persons who have knowledge of the facts set forth herein.

R. H. Phillips, General Manager - Boston [illegible] D hereto.

It is understood by petitioner that should an exemption be granted after full consideration of all facts presented, the term shall not be for a period of less than six (6) months nor for a period of more than two (2) years.

American Airlines, Inc.
(Corporate Name of All-Cargo Service Operator

R. H. Phillips
(Signature of Authorized Representative)

General Manager, Boston
(Title)

9/22/77
(Date of Execution)

State the efforts taken to provide the service by an aircraft certificated in accordance with FAR Part 36.

As we have no FAR 36 aircraft in our Freighter fleet, we cannot provide this all-cargo service with FAR 36 aircraft.

ORIGINAL PAGE IS
OF POOR QUALITY

[illegible] service is essential to the economy of the New England region or a part [illegible] exemption for the
thereof.

Flight 855 presently carries approximately 40,000 pounds of freight nightly, Tuesday through Saturday. Much of this freight is of a size that cannot be accommodated on passenger aircraft.

Airfreight shipments on this flight generally fall into four broad categories requiring next day delivery.

1. Emergency Shipments - replacement orders from the midwest, southwest and west coast requiring next day delivery.

2. Products whose distribution is largely by air on a day-to-day basis because their unit costs preclude large inventories.

3. U.S. Mail - trucked into Logan Air Mail Facility from all over New England; traffic arrives during the evening and is delivered to Postal installations at destination cities the next morning.

4. Perishable Products (seafood, human blood, live animals, biological specimens; newspapers, advertising material, etc.)

These cargo categories listed above come from all over New England; they arrive at Logan Airport between 2100 and 2300 hours and these shippers expect next day delivery at destination. These four categories constitute 85-90% of the total traffic boarded on Freighter Flight 855. If this flight was forced to depart one hour earlier (2345 hours), 25% of the U.S. Mail and 35% of the freight would not reach the airport in time to make this earlier departure. The shippers so affected would be forced to truck to JFK. At best, they would incur increased shipping costs, but most would suffer lost business to competitors in other areas of the country capable of earlier delivery. This sequence of events inevitably leads to layoffs.

Examples of the New England communities/Shippers adversely affected would be:

New Bedford, Mass.	-	Continental Screw Co.
New Bedford, Mass.	-	Acushnet Co.
Attleboro, Mass.	-	Swank Inc.
Attleboro, Mass.	-	Texas Instrument
Foxboro, Mass.	-	Foxboro, Mass.
Brockton, Mass.	-	Garland Knitting Co.
Brockton, Mass.	-	Brockton Footwear Co.
Worcester, Mass.	-	Norton Co.
Worcester, Mass.	-	Melville Shoe Co.
Southboro, Mass.	-	Data General Corp.
Framingham, Mass.	-	General Motors Corp.
Lowell, Mass.	-	General Electric - Wire Division
Gardner, Mass.	-	Simplex Time Recorder

(Attach additional sheets if necessary)

Maynard, Mass.	-	Digital Equipment Corp.
Dover, N. H.	-	Davidson Rubber Co.
Nashua, N. H.	-	Sanders Associates
Nashua, N. H.	-	Nashua Corp.
Manchester, N. H.	-	Raytheon - Marine Products Div.
Rockland, Maine	-	Graffam Bros. (seafood)

Traffic from these shippers would be destined to Cleveland, Detroit, Chicago (mid-west connecting points), Dallas, Los Angeles and San Francisco. These cities are involved because this step backward in time affects not only freighter flight 855 but also backs up the departure of freighter flight 845 from 11:35PM to 10:35PM.

This small sample list of New England cities and shippers provides ample indication that the requested exemption is essential to the economy of these outlying areas of the New England region.

service cannot reasonably be scheduled outside of restricted hours.

As stated in my covering letter, this flight will be <u>scheduled at 0045</u>, (effective November 1, 1977) which is outside the current restricted hours. Last year, it was scheduled to depart at 0120. It was moved forward to its present departure time at the request of Massport prior to the publication of the present noise rules and regulations. This was done in an effort by AA to cooperate with reasonable Massport requests and to reduce late night noise. The November 1, 1977 rescheduling is another instance of our efforts to make reasonable adjustments in a cooperative spirit.

Flight 855 is one of two AA Airfreighter flights from Logan Airport nightly, Monday through Friday. The earlier flight departs at 1145. The departure time of this earlier flight was moved from midnight to accommodate the earlier departure of Flight 855. Approximately 1 hour and 15 minutes is required between freighter flights to allow adequate loading time. This was reduced to 1 hour and 10 minutes in order to schedule the 0055 departure. An all freight aircraft requires extensive and very costly mechanized ground apparatus to load and unload. AA maintains one set of this ground equipment and, consequently, can load and unload one aircraft at a time.

We have explained in detail in attachment B the adverse impact which would occur in various outlying New England cities to specific Shippers in those communities if flight 855 (and consequently 845) were forced back to departure times one hour earlier than at present.

For further substantiation of the detailed explanation in attachment B, I refer you to a publication entitled "The Effects of Limiting Night Flights at Logan Airport" published by Massport in August, 1976.

State any other facts or information which will assist the Executive Director in determining whether the continued operation of this service with non-Part 36 certificated aircraft outweighs the environmental costs of such service.

As previously stated, American Airlines does not possess, at this time, any all-cargo aircraft certificated under Part 36. Consequently, it would be impossible for us to provide this service with other than the aircraft now in operation.

The movement of shipments by air is vital to the health of the New England economy. All cargo flights are a significant factor in the total airfreight picture.

American Airlines currently moves about 120,000 lbs. of freight daily on all of its flights from Logan Airport. Of this total, 65% consistently moves on our two freighter flights 855 and 845. The remaining 35% moves on our combination flights throughout each day. This pattern has evolved as a result of shipper requirements. The pattern is of long standing. It predates the beginning of the jet era in commercial air transportation which began in December 1958.

For a detailed, comprehensive analysis of the economic impact of the cessation of all-cargo operations or their re-scheduling to earlier time periods, I again respectfully refer to the following:

1. The publication entitled "Effects of Limiting Night Flights at Logan Airport" issued in August 1976.
2. The detailed explanation of the adverse impact on the New England economy which would result from re-scheduling American Airlines Freighter flight 855 and 845 one hour earlier effective January 1, 1978 as specified in the Logan Airport Noise Rules and Regulations, Article III.

Re: Noise Abatement Docket No.1977- 7

Petition of American Airlines

PLEASE TAKE NOTICE THAT on September 26, 1977, the Executive Director received from American Airlines a Petition for Exemption from the Authority's Airports Rules and Regulations Article III (Late Night Aircraft Restriction), pursuant to Paragraph 3.4. thereof (exemption for certain all-cargo services). The Petition requests exemption commencing January 1, 1978 for the following service.

Flight Number	Scheduled Arrival Time	Scheduled Departure Time	Weekly Frequency	Aircraft Type and Service
855	0908	0045 (eff. 11/1/77)	5	707 Freighte

Interested persons may inspect the Petition at the Executive Offices of the Authority, 99 High Street, Boston, MA, 02110. The Petitioner /has not requested a hearing. Any person may file prior to November 1, 1977 a written request for a public hearing to be held on the Petition.

Written comments pertaining to the Petition may be submitted to the Authority prior to December 1, 1977, except that if a hearing is requested the date for submission of written comments shall be extended and shall close seven days after the hearing. If a hearing is requested, it will be scheduled on or prior to December 1, 1977 notice to be provided not less than fourteen days in advance by the Authority to the Petitioner and to all others in the same manner as the provision of this Notice.

MASSACHUSETTS PORT AUTHORITY

By: ____________________
Executive Director

Posting Date: October 4, 1977
Removal Date: October 17, 1977

MASSACHUSETTS PORT AUTHORITY

CERTIFICATE OF SERVICE

I hereby certify that I have this day forwarded copies of the within Petition of American Airlines by mailing the same, postage prepaid to: Peter Koff, Esq. City Hall Law Dept., Boston Mass; Rev. Thomas F. Corrigan, Most Holy Redeemer Rectory, 65 London St., E. Boston, Mass; Emily Lloyd, City Hall Mayor's Office, Boston, Mass; Robert L. Weiss, Esq., Boston University Legal Aid Program, 474 Blue Hill Avenue, Roxbury, Mass; John Vitagliano, Housing Inspection Dept., City Hall, Boston, Mass; and Mass. Motor Truck Assoc., Inc., 11 Beacon Street, Boston, Mass. Mr. Lyman Tondel, Jr., Cleary, Gottlieb, Steem & Hamilton, One State Street Plaza, New York, New York 10004, American Airlines, Inc. Logan International Airport, East Boston, Mass. 02128.

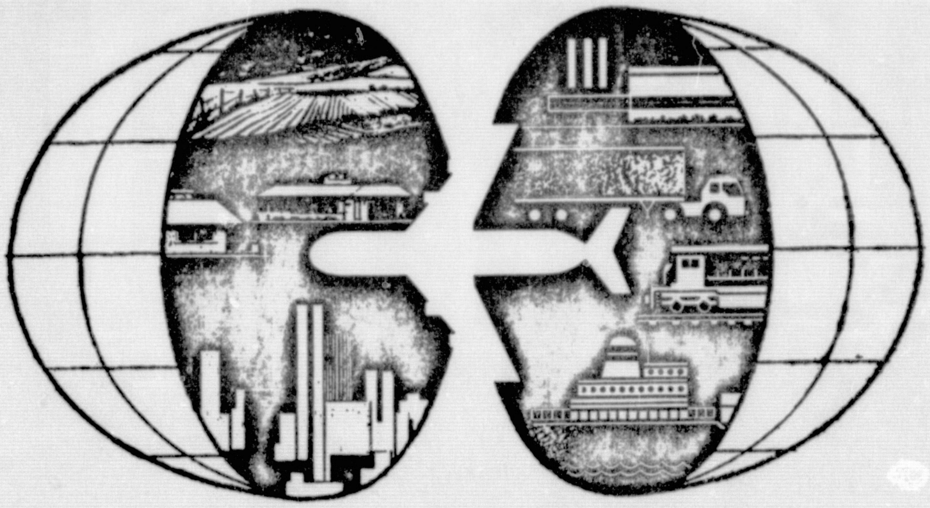
Donna Lambert

October 4, 1977

Donna Lambert

APPENDIX 1D

1990 Transportation Scenario & Advanced Intermodal Air Cargo System Concept



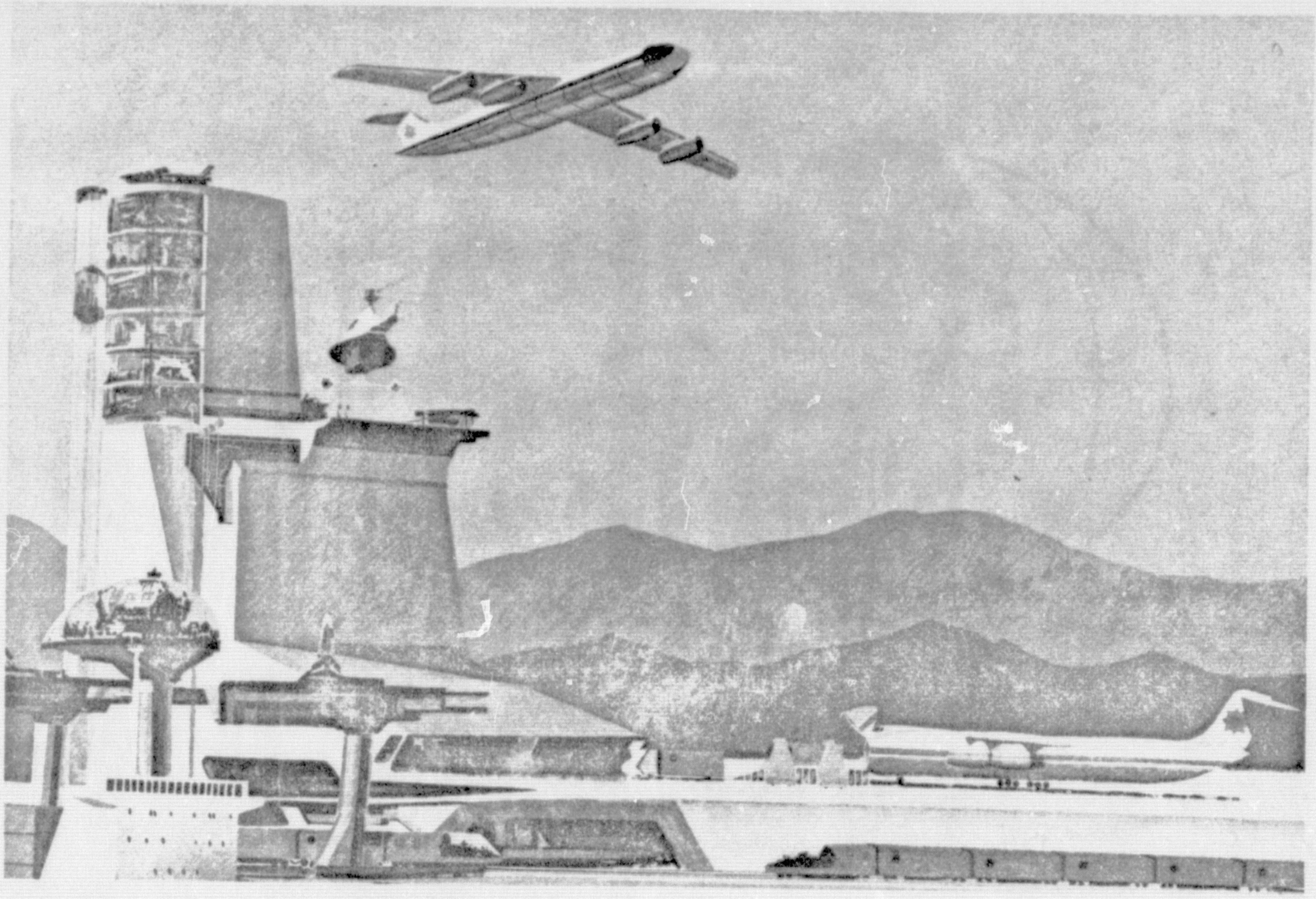
PREFACE

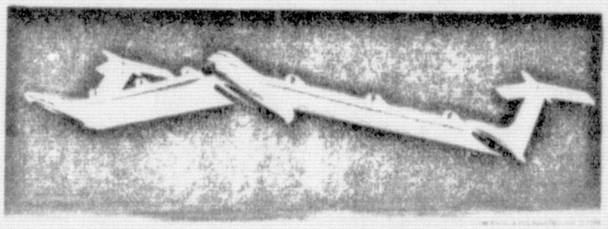
The National Aeronautics and Space Administration (NASA) is responsible for much of the aeronautical research supporting the development of advanced aircraft systems in the U.S. Recent NASA investigations indicate that major advancements in cargo aircraft technology are possible within the next fifteen to twenty years.

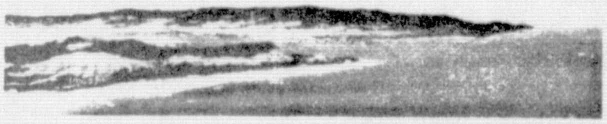
An advanced air cargo system could be developed by the 1990's to provide large-volume freight service completely compatible with surface transportation modes. Greatly improved operating efficiency would reduce the cost of air freight well below today's levels, offering the potential of air shipment for a much wider range of goods and markets.

NASA is now seeking industry assistance in defining future user needs for an advanced air cargo system. Under the Cargo/Logistics Airlift Systems Study (CLASS), information is being sought from shippers and freight carriers on current and future transportation requirements. The results of the CLASS contract will be of major importance to NASA in planning aircraft technology programs for the future.

The Lockheed-Georgia Company is under contract to NASA to conduct the CLASS program. As a part of this contract Lockheed has developed this series of case studies to be made of the transportation and distribution operations of a select group of companies who agree to participate. Trans World Airlines, the Equipment Interchange Association, and D.L. Paden & Associates are assisting Lockheed.







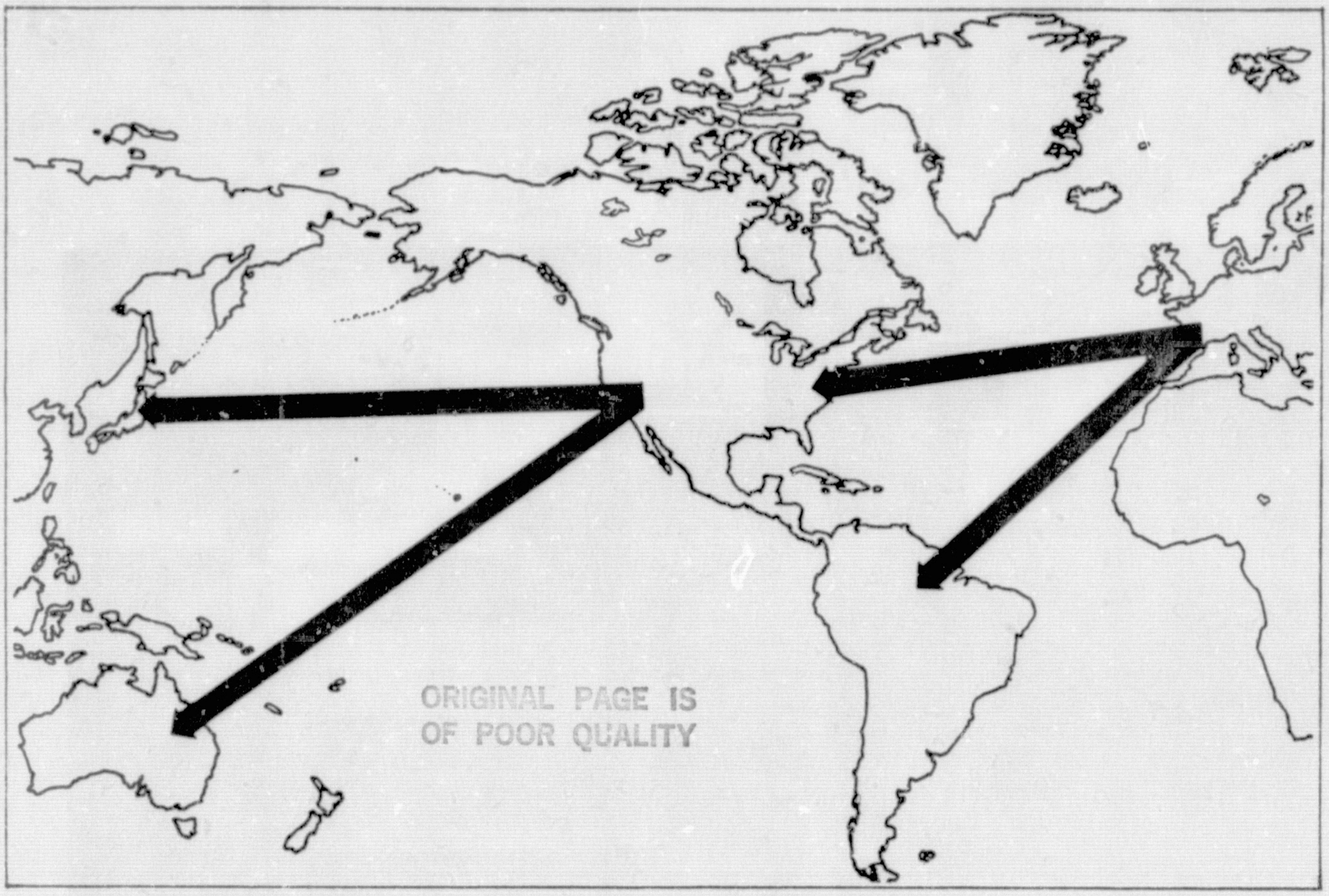
1990 AIR CARGO TRANSPORTATION SCENARIO

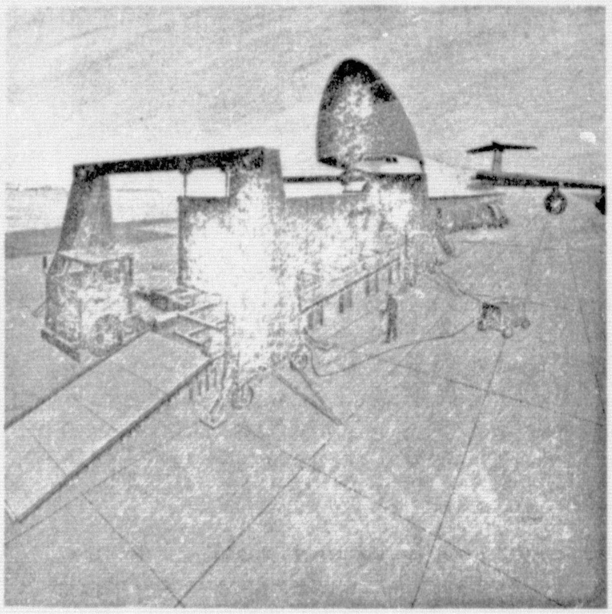
To provide a common base for projecting and evaluating future transportation needs, this scenario describes a set of general conditions that are assumed to exist in the 1990 time frame, including an advanced air cargo system concept, a projected world economic environment, and a characterization of the surface transportation system.

ADVANCED AIR CARGO SYSTEM CONCEPT

This advanced air cargo system concept has evolved from previous NASA and industry analyses, including extensive discussions with freight transportation users and freight carriers. It is to be assumed as the basis for the user and carrier case studies.

- The system will be available in the time period of the 1990's.
- The system will utilize an advanced-technology air freighter optimized for cargo carriage.



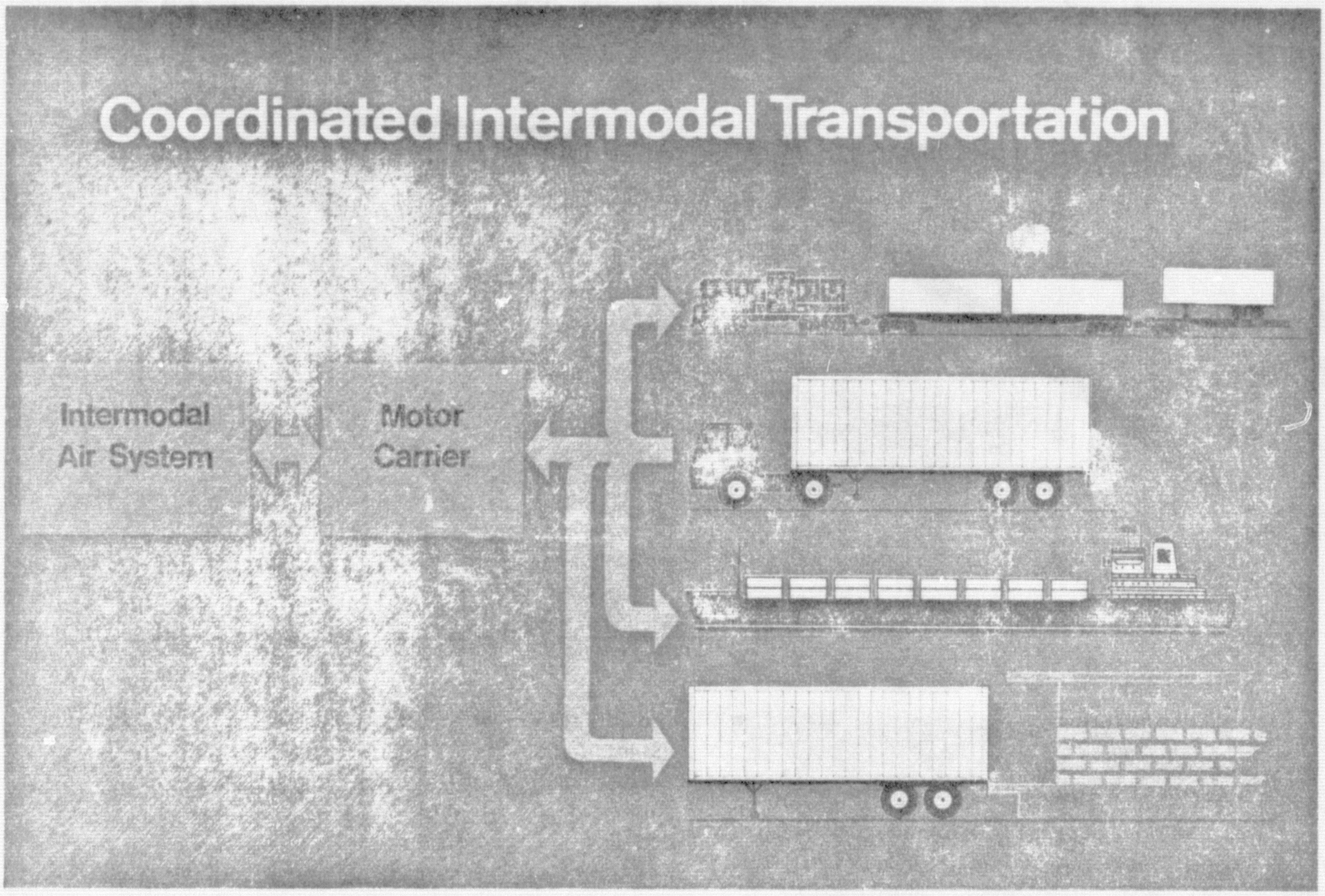


- The advanced freighter aircraft will serve major domestic and international trade routes, primarily on route distances of 800 miles or greater. The aircraft will operate from regional cargo airport centers, which may be separated from congested passenger airports. In some cases, civil freight carriers may utilize military airfields as part of the civil cargo terminal network under joint tenancy arrangements.

- The system will provide mass air movements on routine schedules consistent with the needs of large-volume shippers. Sufficient airlift is assumed to be available to meet the market demand.

- The system will be coordinated surface-to-air-to-surface operation. The motor carrier industry will perform connecting services between the air mode and shippers as well as connecting services with rail and water modes. The airplane will have full intermodal compatibility with the surface transportation segments.

C-3



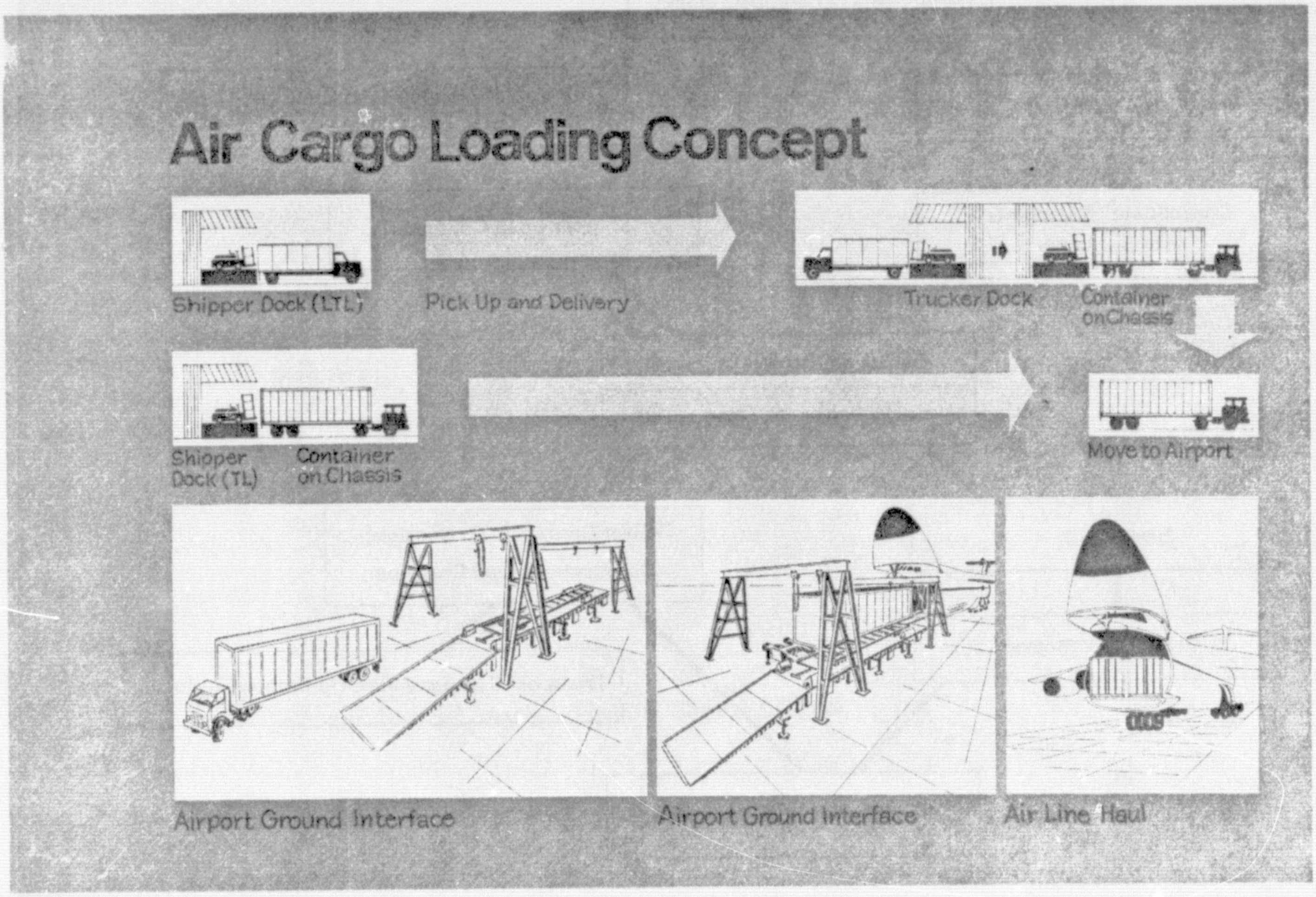
Coordinated Intermodal Transportation

Intermodal Air System

Motor Carrier

- A family of all-mode cargo load devices (containers and/or trailers) will have been developed which are suitable for both air and surface use. Those load devices will be interchangeable among all modes and not captive to any single mode, and they will be fully covered by equipment interchange agreements on all domestic and international routes.

- Surface carriers have the option of offering the air service to their customers as a segment in a door-to-door through movement both domestically and internationally. The air mode would be available as a substitute service similar to rail piggyback arrangements.

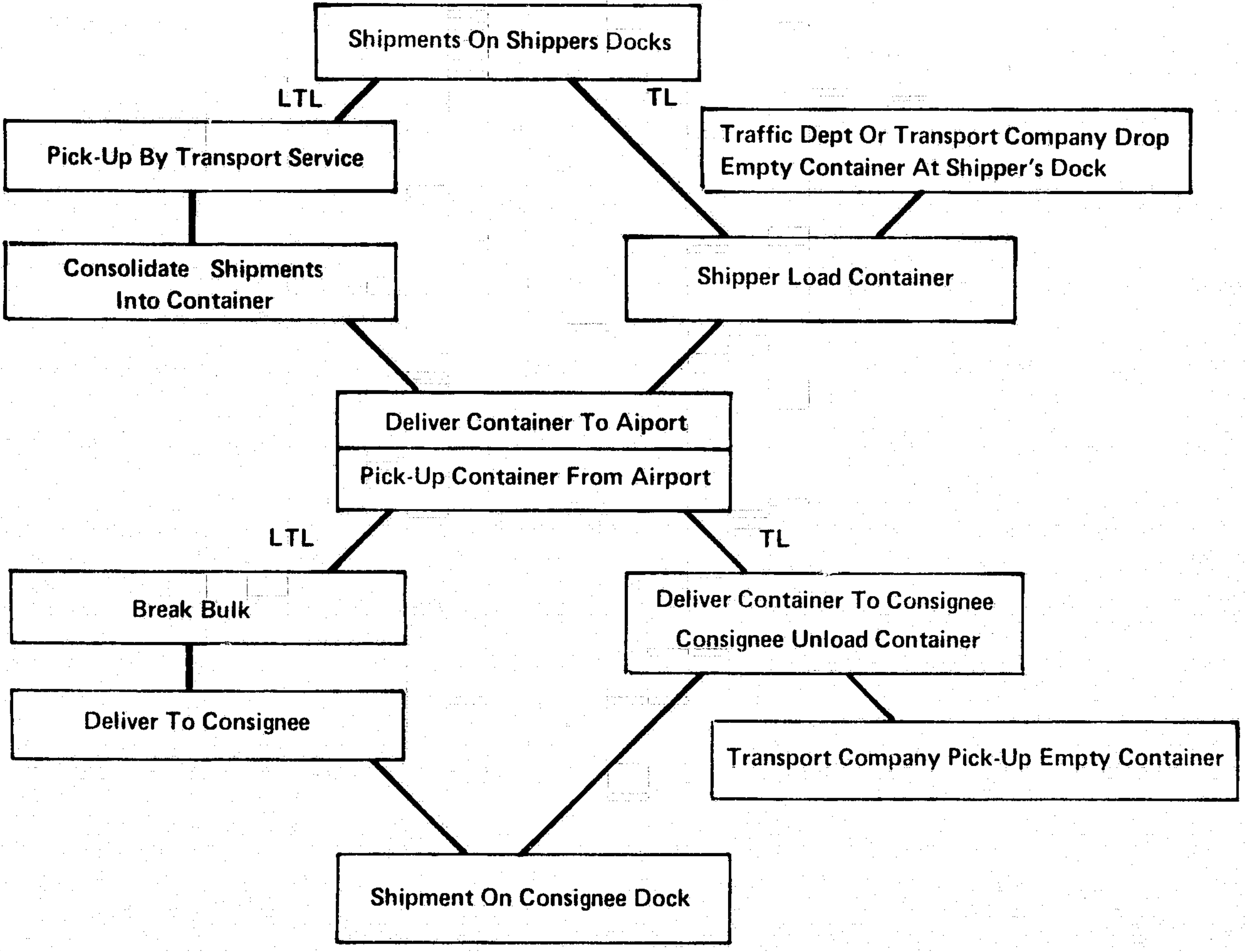


- The system will allow shipments to be packed in truckload or container-load lots by shippers, forwarders, and surface carriers without necessity for additional consolidation or break-bulk processing at the airport. Unitized loads will be trucked to and form the airport centers, possibly for distances up to several hundred miles.

- Tariffs for intermodal service, including the air segment, will be established on a door-to-door basis covering the total freight movement. A single bill of lading and master waybill will be utilized for the entire movement.

- No significant regulatory constraints will act to retard system development or use. Further, future regulatory reforms may permit formation of multimodal transportation consortiums if necessary to achieve full efficiency of an integrated intermodal system.

From a customer service point of view, the future air cargo system should be considered as an additional option available to users within the total transportation environment. The system would have physical and dimensional capability to accept any shipments suitable for normal highway or containership ocean movement. Shippers and transportation companies would be able to use air shipment for any line-haul portion of a freight movement without restriction. Minimum handling of cargo would reduce the risk of pilferage and loss as well as direct handling costs. The system would allow faster reaction to customer orders. Many users could lower their total cost for distribution through savings in line-haul, freight handling, warehousing, insurance, and inventory costs. There may be a significant change in packaging concepts and materials which will further reduce costs.



Pick-Up and Delivery and Consolidation - Break Bulk

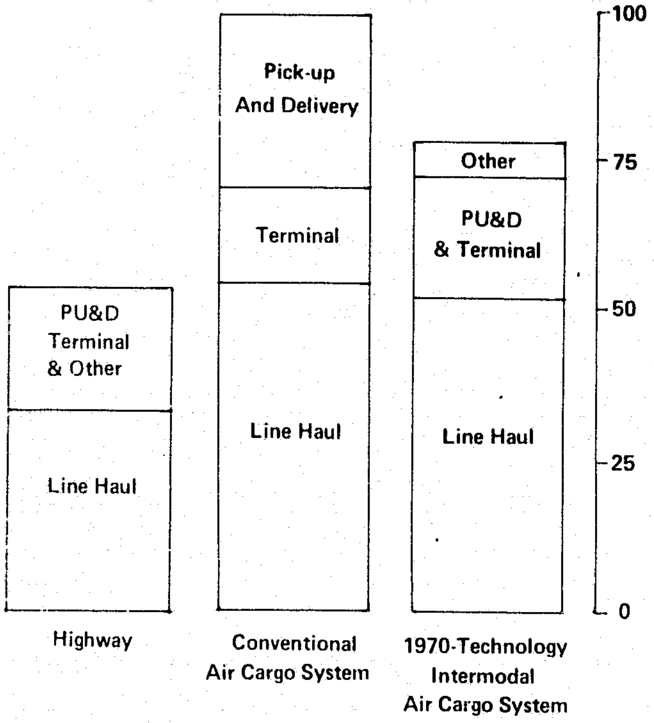
ADVANCED AIR CARGO SYSTEM ECONOMICS

NASA has provided the following economic guidelines for operation of the advanced cargo aircraft:

> "Advanced design concepts would permit savings of 30 percent in direct operating costs (DOC) over current wide-body freighters. Savings of 40 percent in indirect operating costs (IOC) are projected for a containerized, intermodal operation. Aircraft development and operational costs shall be assumed to be shared by the USAF through the CRAF (Civil Reserve Air Fleet) program, resulting in additional savings of 6 - 8 percent in DOC."

The cumulative effect of these cost savings, each of which is related to the air line-haul portion of total distribution costs, has the potential for significant reductions in current air freight rates.

Other system costs include those for pick-up and delivery (PU&D) and, for less than truckload (LTL) shipments, there are additional costs for consolidation and break bulk functions. For this scenario, it is assumed that existing motor carrier cost factors will be applicable for these functions.



Distribution of System Cost by Function 2500 Mile Trip

Representative system cost breakdowns for motor carrier, conventional air cargo, and current-technology intermodal air cargo systems illustrate the fact that air movements of freight on long haul domestic and international routes that combine intermodal surface/air operations indicate an appreciable cost savings over current air freight operations. These data for an intermodal air freight system were developed assuming the use of current technology and were tentatively verified during a recent government/industry intermodal air cargo flight demonstration - Project INTACT.

With a verification of significant user need for domestic and international intermodal air freight systems, it is well within the realm of possibility that advanced technology developments by NASA could further reduce costs of an integrated surface-to-air transportation system. Potential additional cost savings in a user's physical distribution system must be analyzed by the individual company - a subject that is addressed as part of the case study.

1990 SURFACE FREIGHT TRANSPORTATION

By the time that an advanced intermodal air cargo system becomes operational, changes will also have occurred in surface freight modes. Although some evolutionary improvements can be expected in service and cost factors, no revolutionary advances are antiticpated.

This scenario assumes that there will be no abnormally large increases in the cost of petroleum fuels (such as the increase in crude oil price in 1973) in the period between now and 1990. For all modes it appears that emphasis on fuel conservation and application of fuel-efficient technology will approximately balance the real increases in cost of fuel. Thus, up to the 1990 period considered in the study, it is assumed that energy availability and cost will not have significant impact on the modal split.

Three surface transport modes are considered to have an impact on potential markets for an advanced air cargo system - rail, highway, and containership. Following the short-term lags experienced in 1974-75, all three are expected to resume growth trends, but generally at slower rates than have been experienced in the past. Other surface transport modes - inland waterways and pipelines - are not considered to compete for air-eligible commodities.

Rail systems along major trunk routes will be revitalized. The number of carriers will be reduced as major mergers create carriers with transcontinental/major regional scopes of operation. Main trunk lines will be upgraded, with possible electrification of some, while redundant and secondary mileage continues to be eliminated. Ton-mile capacity will be greatly increased but will largely be absorbed by increased movements of bulk commodities, particularly coal and foodstuffs, TOFC/COFC operations will continue their growth trend.

Highway capacity growth will be constrained by the lack of new highway construction in the 1980's and increased maintenance requirements on the existing system. Normal growth trends in trucking capacity will be marginally increased by relaxation of truck weight and size limitations. Economics of the common carrier system will be eroded by increased utilization of private trucking as economic growth creates more shippers with sufficient volumes to warrant this type of operation. Transit times will increase as the total highway traffic in many urban and rural areas increasingly exceeds design volumes.

Rail and highway trends in other developed countries will generally parallel those in the U.S. In the developing nations, the simultaneous problems of right-of-way acquisition, facility construction, transport equipment acquisition, and the competition for resources by other national needs will continue to hamper well-developed surface transport systems.

Containership, ro-ro, and barge-carrier systems will expand their penetration of international maritime commerce relative to the share presently carried by break-bulk cargo vessels. At the same time, a small portion of containership and ro-ro shipments will be attracted to the advanced air cargo system.

As the demand for surface freight transportation increases during the next 15 years, service degradations resulting from congestion and maintenance will be more commonplace. Nevertheless, the system will manage to provide both adequate volume capacity and suitable route flexibility. As the surface movement of a variety of moderately-sized shipments of finished goods becomes less efficient and more costly, relative to their total production/distribution costs, air shipment will become more desirable and routine.

1990 WORLD ECONOMIC SCENARIO

The following world economic factors are assumed to prevail in 1990 for the purpose of evaluating the usage of an advanced intermodal air cargo system:

- Peaceful co-existence will continue among the major world powers. Changes in spending levels for military preparedness will not be significant.
- Periodic conflicts will erupt within and between smaller nations but they will be resolved without major escalation or serious threat to world peace.
- Trade between the free world and the controlled economies will increase more rapidly than in the 1970s but will not constitute major markets.
- Major energy and raw material consumers will remain vulnerable to OPEC oil embargoes and other potential cartels of resource exporting nations. However, the resource exporters will steer a moderate course which does not precipitate further economic crises.
- World population will be over 5 billion, a 35% increase from 1975. About 90% of the increase will occur in Asia, Africa/Mideast, and Latin America. As the world population growth rates begin to slow in late 1980s, the percentage of labor force age will increase.
- World Gross Domestic Product will double during the same 15-year period. About one-half the increase will occur in North America, Western Europe, and Japan - regions with only 15% of the world population.
- Domestic rail and highway freight requirements will increase by about 50%. International trade will more than double.

The foregoing factors reflect an economic environment resulting from generally surprise-free continuation of recognized trends. In total, they are conducive to reasonable expansion in international trade and to the development of advanced transportation systems which , in turn, should have a positive feedback effect on trade expansion.

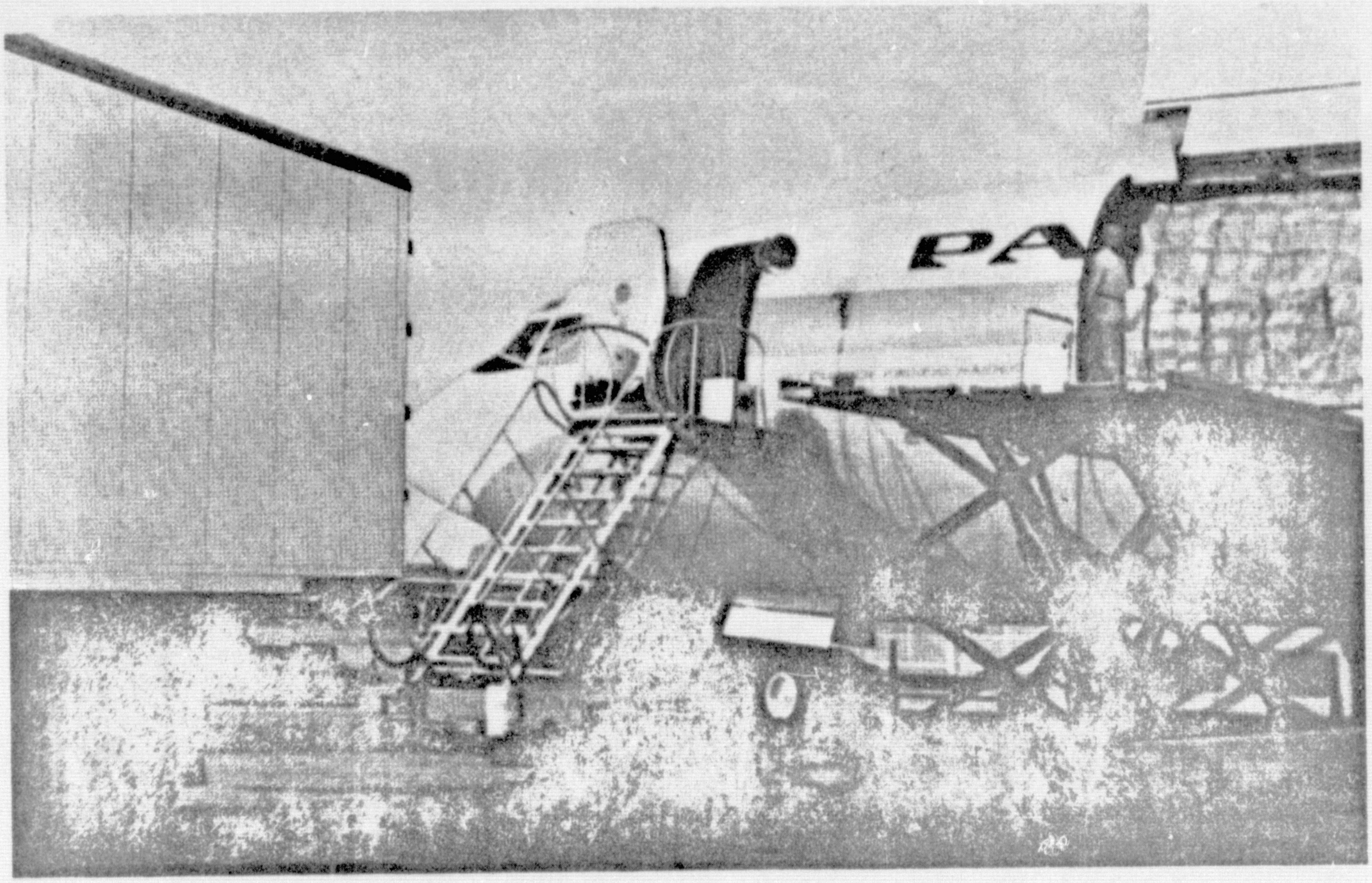
ADVANCED AIR CARGO SYSTEM STATUS

This section provides additional background information about the status of advanced air cargo sytem planning, circumstances surrounding the need for such a system, NASA's role in system development, and the importance of industry case studies to NASA's CLASS project.

Today's Air Cargo System

During the past two decades, the U.S. and international air freight industry has been characterized by development of new markets, rapid growth in traffic volume, and heavy capital investment resulting in expanded capacity. Regularly scheduled flows of air freight now connect all domestic and international trade centers.

In 1976, U.S. domestic intercity air cargo totaled about 3.8 billion ton-miles, about on-fourth of the free world total. The U.S. domestic annual growth rate for 1970 - 1976 was 3.8 percent. U.S. and foreign international air cargo growth for the same period was 10.1 percent in total and substantially higher for developing markets.



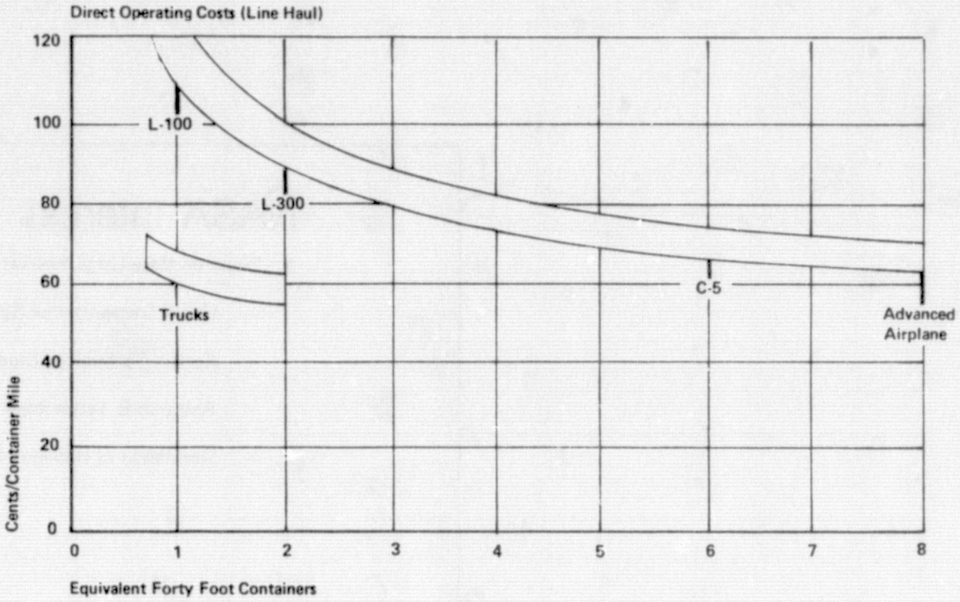
Despite its rapid growth and emerging maturity, the existing air freight system is basically limited to small shipments of high-value and/or time-sensitive commodities and to emergency shipments of additional products. Less than half of all air cargo moves in dedicated all-cargo aircraft; the all-cargo aircraft are non-optimum configurations derived from passenger designs. The pallets and containers are specially designed for the air transportation mode without regard for high-volume efficient linkage with the surface transport modes.

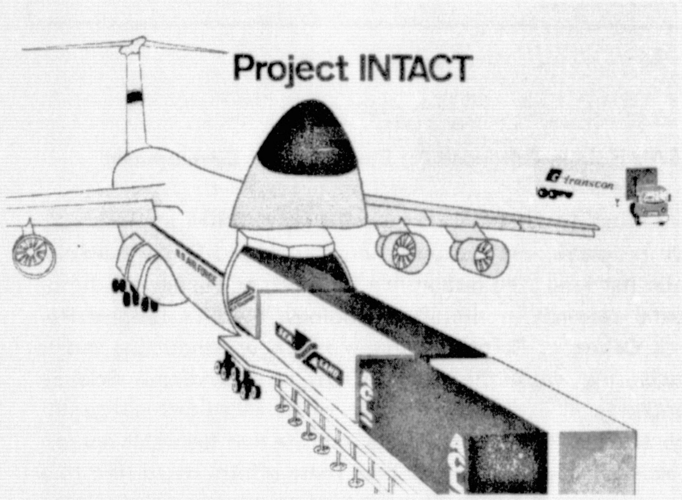
Civil Reserve Air Fleet (CRAF) Cargo Deficit

Future Needs

The Department of Transportation has expressed serious concern about the ability of our surface transportation systems to meet the nation's physical distribution requirements over the next fifteen to twenty years. Domestic freight transportation requirements are projected to double during the period from 1970 to approximately 1990, and there is growing doubt that highway and rail capabilities can be improved and expanded sufficiently to meet total demand. Foreign international transportation requirements for post-1990 are potentially an order of magnitude greater than our domestic needs. An expanded air cargo system, suited to volume movements and compatible with the surface network could absorb a greater share of this growth.

The Department of Defense is concerned by the current shortage of all-cargo airlift capacity in the military fleet. The situation is compounded by a further shortage in the commercial fleet which could be mobilized to meet national emergencies. Studies are now being pursued by industry and the Air Force for a large cargo airplane that could meet both commercial and military needs without undue compromise to either.





There is growing evidence that a large freighter airplane, designed and dedicated exclusively for cargo use, would be of major benefit to commercial transportation users, the consumer public, and the military. A large cargo aircraft, incorporating the latest technological advances and designed for compatibility with surface transport modes, offers the prospect of significantly increasing operating efficiencies and reducing the cost of air shipments.

The technical feasibility of intermodal air cargo operations on a volume basis has been demonstrated through an experimental program known as Project INTACT (Intermodal Air Cargo Test). In this joint government-industry program conducted under the leadership of the U.S. Department of Transportation, a wide range of conventional commercial freight was transported by air for the first time in standard 40′ highway trailers and 8′ x 8-1/2′ x 40′ surface containers. In demonstration flights conducted in October 1975, van trailers and intermodal marine containers were packed by shippers at their own facilities, driven to the airport, and loaded directly into an Air Force heavy lift C-5A airplane with no further rehandling of the freight itself.

NASA Interest

- Proposed Very Large Aircraft Systems Technology Program
  - Cargo Transportation System Studies
  - System Technology Studies
  - Research & Technology Studies
  - Simulation of Handling Qualities

NASA's Role in Advanced Air Cargo System Development

In addition to its highly successful stewardship of America's space programs, the National Aeronautics and Space Administration has long been responsible for much of the nation's fundamental research in aircraft technology. NASA's Langley Research Center at Hampton, Virginia, is now conducting and is participating with the DOT, DOD, and National Science Foundation in exploratory studies of advanced-technology all-cargo aircraft. Preliminary results indicate that favorable operating economics would be possible. These efforts could lead to a national program for development of an advanced airfreighter for the 1990 time period.

NASA Air Cargo Workshop

Langley - February 1976

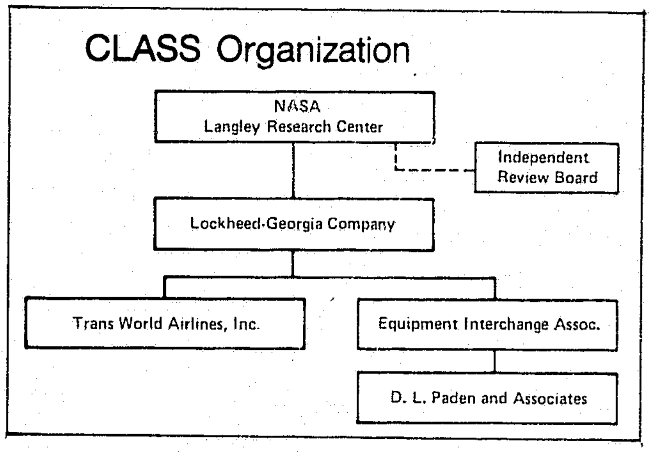
Purpose - To Obtain Industry Users Views on Need and General Guidelines for a New Large Freighter Aircraft

Results - Strong Industry Support for New Air Cargo System - Physically and Economically Compatible with Surface Modes

Confirmation of Validity of NASA Advanced Civil/Military Air Cargo Systems Study Initiatives

NASA Sponsorship of Cargo Transportation System Studies

In February 1976, NASA Langley sponsored an air cargo workshop to obtain industry views on needs and applications for an advanced all-cargo airplane. A number of shippers and transportation-oriented companies were represented. Consensus expressed at the workshop was that a definite need exists for expanded air cargo capability suited for repetitive large-volume movements. Participants also recommended that NASA seek the detailed guidance of shippers and surface carriers in identifying specific operational and economic criteria for the advanced air cargo system.

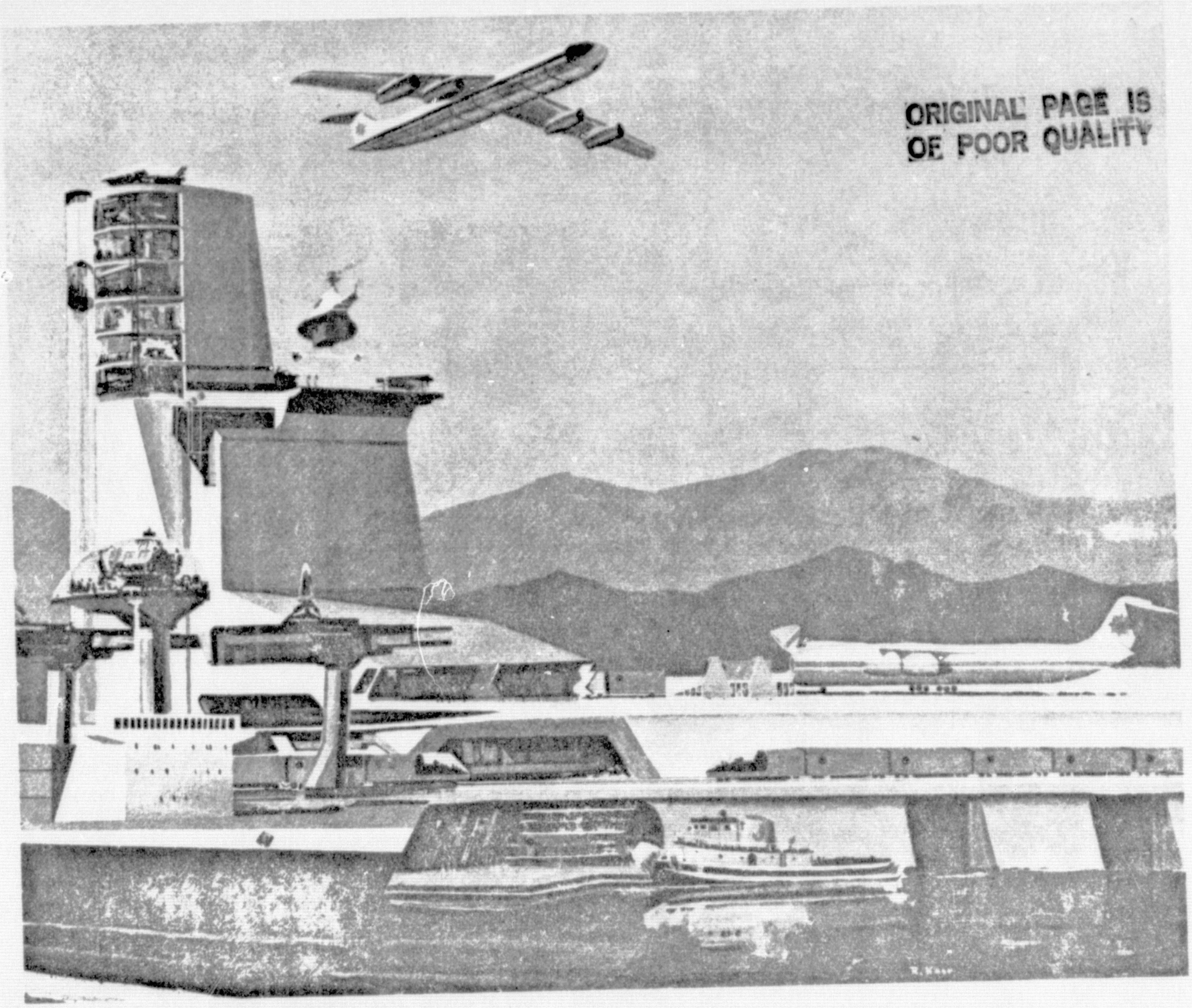

CLASS Organization

NASA's CLASS Project

In the present Cargo/Logistics Airlift System Study (CLASS), NASA seeks to determine more specifically the nature of user needs for an advanced intermodal air freight capability in the 1990 time period. The results will provide important guidance for advanced cargo aircraft research and technology programs.

NASA has contracted with the Lockheed-Georgia Company for assistance in conducting study. Lockheed heads a study team consisting of Trans World Airlines (TWA), the Equipment Interchange Association (EIA) and D.L. Paden & Associates.

TWA, as a leading air freight carrier, will develop an analysis of a normal-evolution air crago system assuming that no all-new cargo aircraft will be developed in the next twenty years. EIA, an intermodal transportation association with membership from truck, rail, ocean, and air modes, will provide expert knowledge on modal interfaces and will also play a major role in case study arrangements. D.L. Paden & Associates, physical distribution and industrial survey research consultants, has designed the case study program, will participate in company interviews, and will compile case study results for Lockheed. Lockheed will manage the program and integrate overall study results for submittal to NASA's Langley Research Center. NASA will be assisted by a special advisory committee consisting of a representative from the shipping community, the U.S. Department of Transportation, and the U.S. Air Force.

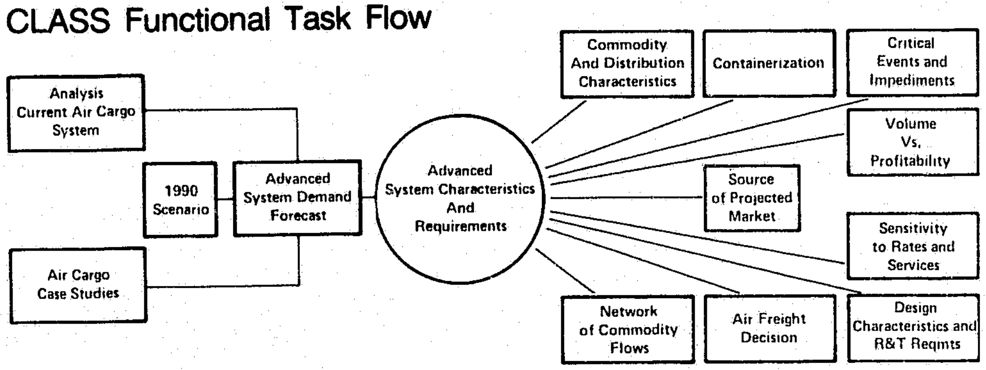


Why Case Studies?

It is expected that an advanced technology air freighter would accommodate a much wider range of commodity and geographic markets than is possible with today's air cargo system. However, these air freight markets cannot be accurately forecasted by conventional methods from gross statistical data on freight movements, since the new air freight system would be expected to attract types of freight presently limited to surface transportation. These markets can only be defined on the basis of specific information from individual companies which might be expected to utilize the expanded air system in their normal distribution/transportation operations.

Because of the critical need for specific information, NASA and Lockheed have agreed to conduct in-depth case studies of a number of representative companies. Several different types of shippers are included to provide a range of industrial, commercial, and agricultural products as well as geographical locations and company sizes. Both international and domestic distribution networks are of interest.

CLASS Functional Task Flow



Freight forwarders and surface carriers are also included in the case studies. Inclusion of surface carriers is important because their present operations include a wide range and mix of freight movements that might be candidates for future long-haul transportation; also, carriers may be potential participants in the future air system in terms of substitute and connecting service for their customers.

Results of the case studies will be instrumental in determining the scope and timing of technical activities by NASA toward development of a new cargo airplane program. Information obtained from the shipper and carrier communities is crucial to NASA's assessment of national need for an advanced system of this type. At this point, the future course of the technology program is dependent upon the participation and cooperation of shippers and carriers who are leaders and innovators in their field. At the same time, the case study effort offers a unique opportunity for users to influence the development of a system concept that best serves their future transportation requirements.

How Will This be Done?

Information will be collected through special case study booklets and personal interviews. Participating companies will be provided these case study booklets and detailed instructions on the overall study and the specific information sought. Each company is then requested to complete the case study booklets applicable to its line of business, with supporting data in certain areas. Follow-up interviews, either in person or by phone, will be made to obtain any necessary clarification or expansion of the data.

AMF
Bassett
Black & Decker
Burlington Industries
Caterpillar Tractor
Clark Equipment
DAB Industries
Eastman Kodak
E.I. Dupont
Eli Lilly
Ex-Cell-O
Ford Motor Co
Food Fair Stores
General Motors
Genesco
Goodyear
Hercules
IBM
International Harvester
J.C. Penney
McCormick
McGraw-Hill
RCA
Safeway
Scott
Sears Roebuck
Texas Instruments
United Brands
Westinghouse
Whirlpool

Bud Antle
Florida Citrus Growers
Goldkist
Grower-Shipper Vegetable Assoc.
Monfort of Colorado
Iowa Beef Processors
Western Growers Assoc.
United Parcel Service
Universal Car Loadings
Emery Air Freight
Consolidated Freightways
Pacific Intermountain Express
Yellow Freight Lines
Associated Freight Lines
Georgia Highway Express
Allied Van Lines
North American Van Lines
C&H Transport
Metler Crane & Erection Service
Atlantic Transfer Co.
Burlington Northern
Southern Railway
American President Line
Sea-Land Services
U.S. Lines

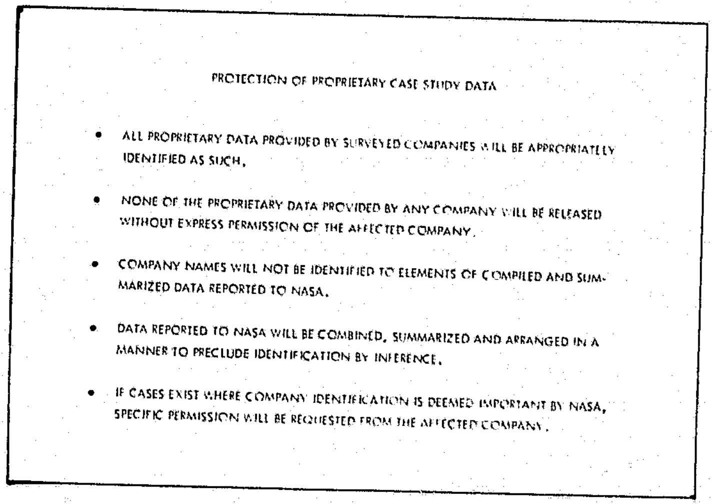
CLASS Case Study Data

- Current Distribution and Transportation Operations
- Decision Criteria and Process for Selecting Air Mode in Lieu of Surface Modes
- Assessment of Air Mode Selection Sensitivity
- Desired Attributes of Advanced 1990 Air Cargo System
- Estimated Future Use of Advanced Air Cargo System

Information obtained through the survey will be reduced and compiled in summary report form for submittal to NASA. Companies participating in the survey will be provided a report of case study results.

Information generated by the case studies includes:

- Data on the company's current distribution/transportation network, to identify freight movements that would be likely candidates for line-haul air movement by an advanced system;
- Criteria by which air service would be selected in lieu of existing surface routings;
- Projected volumes of freight for the advanced air system;
- Characteristics and capabilities required in the air system to meet user needs.



PROTECTION OF PROPRIETARY CASE STUDY DATA

- ALL PROPRIETARY DATA PROVIDED BY SURVEYED COMPANIES WILL BE APPROPRIATELY IDENTIFIED AS SUCH.
- NONE OF THE PROPRIETARY DATA PROVIDED BY ANY COMPANY WILL BE RELEASED WITHOUT EXPRESS PERMISSION OF THE AFFECTED COMPANY.
- COMPANY NAMES WILL NOT BE IDENTIFIED TO ELEMENTS OF COMPILED AND SUMMARIZED DATA REPORTED TO NASA.
- DATA REPORTED TO NASA WILL BE COMBINED, SUMMARIZED AND ARRANGED IN A MANNER TO PRECLUDE IDENTIFICATION BY INFERENCE.
- IF CASES EXIST WHERE COMPANY IDENTIFICATION IS DEEMED IMPORTANT BY NASA, SPECIFIC PERMISSION WILL BE REQUESTED FROM THE AFFECTED COMPANY.

Protection of Data

Some elements of data requested in the case studies may be considered by particular companies to be of a sensitive competitive nature and not suitable for public disclosure. To protect any information of possible proprietary nature, the following procedures will be followed:

- None of the raw data provided to the study team by a participating case-study company will be released by Lockheed to NASA or outside parties without the express permission of that company.
- In the study report, company names will not be identified to specific data. If company identification appears desirable for isolated elements of information in the report, specific permission will be obtained from the affected company.
- Data in the report will be arranged and combined in a manner to preclude company idnetification by inference from the data.

If additional, more stringent data protection procedures are considered necessary by a particular company, Lockheed will be pleased to discuss any special arrangements that seem appropriate.

APPENDIX III-A

CARLOAD WAYBILL STATISTICS

APPENDIX III-A
TABLE III-1E-1

CARLOAD WAYBILL STATISTICS
ALL COMMODITIES - RANKED BY REVENUE PER TON-MILE

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	CUM %	TON-MILES (THOUS)	% OF TOTAL	CUM %	CENTS PER TON-MILE
259	Misc Furn. or Fixtures	3,067	0.02	0.02	2,634	0.05	0.05	9.07
251	Household or Off. Furn.	9,185	0.07	0.09	7,737	0.14	0.19	8.91
341	Metal Cans	3,013	0.02	0.11	2,153	0.04	0.23	8.70
306	Misc Fabricated Rubber	1,579	0.01	0.12	1,083	0.02	0.25	7.89
394	Toys, Amuse or Sport. Goods	2,025	0.02	0.14	1,878	0.03	0.28	7.50
363	Household Appliances	17,064	0.14	.28	14,977	0.27	0.55	7.34
371	Motor Vehicles	243,228	1.94	2.22	196,767	3.56	4.11	7.01
358	Service Indus Mach's	2,114	0.02	2.24	1,798	0.03	4.14	6.92
307	Misc Plastic Prods	9,383	0.07	2.31	7,685	0.14	4.28	6.34
411	Misc Freight Shipments	3,760	0.03	2.34	2,803	0.05	4.33	6.26
352	Farm Machinery or Equipment	7,083	0.06	2.4	6,945	0.13	4.46	6.02
19	Ordnance or Access	3,126	0.02	2.42	2,471	0.04	4.5	5.68
23	Apparel	1,774	0.01	2.43	1,413	0.03	4.53	5.62
229	Misc Textile Goods	5,529	0.04	2.47	3,941	0.07	4.6	5.47
364	Elec Lighting or Wire Equip	2,004	0.02	2.49	1,980	0.04	4.64	5.36
353	Const'n Mach'y or Equip	10,966	0.09	2.58	10,343	0.19	4.83	5.06
205	Bakery Products	2,908	0.02	2.6	2,538	0.05	4.88	4.89

APPENDIX III-A
TABLE III-1E-2

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	CUM %	TON-MILES (THOUS)	% OF TOTAL	CUM %	CENTS PER TON-MILE
301	Tires or Inner Tubes	17,528	0.14	2.74	13,392	0.24	5.12	4.85
265	Containers or Boxes, Paperbd	11,575	0.09	2.83	7,441	0.13	5.25	4.83
365	Radio or TV Rec. Sets	2,098	0.02	2.85	2,256	0.04	5.29	4.68
38	Instru. or Photo Goods	1,129	0.01	2.86	1,075	0.02	5.31	4.53
332	Iron or Steel Castings	19,739	0.16	3.02	5,788	0.10	5.41	4.50
349	Misc. Fab. Metal Prod.	6,978	0.06	3.08	5,163	0.09	5.5	4.39
264	Converted Paper, Etc.	54,295	0.43	3.51	38,577	0.70	6.2	4.39
31	Leather or Leather Prod.	647	0.01	3.52	374	0.01	6.21	4.37
402	Waste or Scrap	334,763	2.67	6.19	86,060	1.56	7.77	4.10
339	Misc. Primary Metal Prod.	7,253	0.06	6.25	3,231	0.06	7.83	4.05
322	Glass or Glassware	8,165	0.07	6.32	7,541	0.14	7.97	4.03
374	Railroad Equip	24,676	0.20	6.52	12,523	0.23	8.2	4.00
227	Floor Coverings	2,627	0.02	6.54	2,884	0.05	8.25	3.86
344	Fab. Struct Metal Prod.	44,390	0.39	6.93	30,397	0.55	8.8	3.84
421	Cont. Ship'g, Ret. Empty	6,676	0.05	6.98	5,716	0.10	8.9	3.71
331	Steel Works Prod.	363,199	2.89	9.87	133,500	2.42	11.32	3.53
284	Soap or Other Detergents	14,045	0.11	9.98	12,020	0.22	11.54	3.48
211	Cigarettes	4,928	0.04	10.02	6,689	0.12	11.66	3.42
207	Confectioner or Rel. Prod.	3,317	0.03	10.05	3,489	0.06	11.72	3.38

APPENDIX III-A
TABLE III-1E-3

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	CUM %	TON-MILES (THOUS)	% OF TOTAL	CUM %	CENTS PER TON-MILE
201	Meat, Fresh, Chilled	36,275	0.29	10.34	26,755	0.48	12.2	3.38
295	Paving or Roofing Mat'ls	12,295	0.10	10.44	5,317	0.10	12.3	3.29
202	Dairy Products	12,024	0.10	10.54	9,063	0.16	12.46	3.23
106	Manganese Ores	9,089	0.07	10.61	2,787	0.05	12.51	3.18
286	Gum or Wood Chem.	7,305	0.06	10.67	5,206	0.09	12.6	3.09
451	Shipper Assoc or Sim. Traff.	46,592	0.37	11.04	58,754	1.06	13.66	3.08
327	Concrete, Gypsum Prod.	72,128	0.57	11.61	22,749	0.41	14.07	2.96
461	Misc Mixed Shipments	159,167	1.27	12.88	161,957	2.93	17.00	2.96
291	Prod. of Petro Ref'g.	215,226	1.71	14.59	109,307	1.98	18.98	2.95
335	Nonferrous Metal Basic	23,311	0.19	14.78	23,677	0.43	19.41	2.89
289	Misc. Chem. Prod.	69,174	0.55	15.33	51,468	0.93	20.34	2.88
204	Grain Mill Products	333,332	2.65	17.98	175,030	3.17	23.51	2.87
441	Frt Fwdr. Traffic	28,546	0.23	18.21	45,445	0.82	24.33	2.87
262	Paper	112,275	0.89	19.1	89,772	1.63	25.96	2.85
282	Plastic Materials	100,353	0.80	19.9	86,778	1.57	27.53	2.82
266	Building Paper or Board	20,790	0.17	20.07	17,083	0.31	27.84	2.82
013	Fresh Vegetables	19,769	0.16	20.23	36,761	0.67	28.51	2.81
012	Fresh Fruits or Tree Nuts	10,325	0.08	20.31	21,250	0.38	28.89	2.74
324	Hydraulic Cement	156,799	1.25	21.56	42,420	0.77	29.66	2.73

APPENDIX III-A
TABLE III-1E-4

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	CUM %	TON-MILES (THOUS)	% OF TOTAL	CUM %	CENTS PER TON-MILE
27	Printed Matter	2,433	0.02	21.58	3,544	0.06	29.72	2.66
109	Misc. Metal Ores	19,893	0.16	21.74	6,369	0.12	29.84	2.62
111	Anthracite	21,975	0.17	21.91	6,732	0.12	29.96	2.62
144	Gravel or Sand	330,329	2.63	24.54	65,291	1.18	31.14	2.56
299	Misc. Coal or Petro. Prod.	190,456	1.52	26.06	80,158	1.45	32.59	2.56
208	Beverages or Flav'g Extracts	117,050	0.93	26.99	105,834	1.92	34.51	2.53
281	Indus. Inorganic Chem.	555,607	4.42	31.41	387,439	7.02	41.53	2.53
329	Abrasives or Asbestos	244,942	1.95	33.36	137,544	2.49	44.02	2.51
101	Iron Ores	1,117,254	8.90	42.26	137,429	2.49	46.51	2.51
263	Fiberboard, Etc.	184,772	1.47	43.73	137,147	2.48	48.99	2.48
209	Misc. Food Prep.	223,952	1.78	45.51	134,536	2.44	51.43	2.46
249	Misc. Wood Products	43,202	0.34	45.85	49,362	0.89	52.32	2.42
422	Trailers, Semi's, Ret. Empty	4,023	0.03	45.88	2,653	0.05	52.37	2.40
241	Primary Forest Matl's	614,557	4.89	50.77	99,339	1.80	54.17	2.39
287	Agricultural Chem.	136,328	1.09	51.86	73,112	1.32	55.49	2.37
08	Forest Products	5,589	0.04	51.9	6,137	0.11	55.6	2.34
203	Canned or Pres'd Fruits	87,645	0.70	52.6	126,685	2.30	57.9	2.33
325	Struct. Clay Prod.	49,754	0.40	53.0	27,892	0.51	58.41	2.32
206	Sugar, Beet or Cane	76,434	0.61	53.61	60,060	1.09	59.5	2.28

APPENDIX III-A
TABLE III-1E-5

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	CUM %	TON-MILES (THOUS)	% OF TOTAL	CUM %	CENTS PER TON-MILE
243	Millwork Products	78,303	0.62	54.23	106,607	1.93	61.43	2.26
333	Non-Ferrous Metal	64,562	0.51	54.74	72,923	1.32	62.75	2.25
142	Crushed or Broken Stone	459,313	3.59	58.33	73,694	1.34	64.09	2.24
011	Field Crops	1,155,751	9.20	67.53	520,006	9.42	73.51	2.24
242	Sawmill Products	149,614	1.19	68.72	198,001	3.59	77.1	2.21
105	Bauxite or Other Al. Ores	63,162	0.50	69.22	31,308	0.57	77.67	2.14
103	Lead or Zinc Ores	22,321	0.18	69.4	8,502	0.15	77.82	2.10
261	Pulp or Pulp Mill Prod.	55,865	0.44	69.84	48,980	0.89	78.71	2.06
145	Clay, Ceramic or Refractory	30,157	0.24	70.08	14,139	0.26	78.97	2.06
149	Misc. Nonmetallic Min'ls	53,056	0.42	70.5	31,634	0.57	79.54	1.98
09	Fresh Fish, Etc.	1,023	0.01	70.51	889	0.02	79.56	1.98
131	Crude Petroleum or N.G.	20,786	0.17	70.68	8,373	0.15	79.71	1.82
147	Chemical or Fert. Min'ls	431,656	3.44	74.12	65,556	1.19	80.9	1.79
112	Bituminous Coal	3,120,264	24.85	98.97	998,381	18.09	98.99	1.64
102	Copper Ores	75,613	0.60	99.57	12,445	0.23	99.22	1.57

APPENDIX III-A
TABLE III-2E-1

CARLOAD WAYBILL STATISTICS

MANUFACTURED GOODS - RANKED BY REVENUE PER TON-MILE

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	CUM %	TON-MILES (THOUS)	% OF TOTAL	CUM %	CENTS PER TON-MILE
259	Misc Furn. or Fixtures	3,067	.06	.06	2,634	.09	.09	9.07
251	Household or Off. Furn.	9,185	.19	.25	7,737	.25	.34	8.91
341	Metal Cans	3,013	.06	.31	2,153	.07	.41	8.70
306	Misc Fabricated Rubber	1,579	.03	.34	1,083	.04	.45	7.89
394	Toys, Amuse or Sport Goods	2,025	.04	.38	1,878	.06	.51	7.50
363	Household Appliances	17,064	.34	.72	14,977	.49	1.0	7.34
371	Motor Vehicles	243,228	4.9	5.62	196,767	6.42	7.42	7.01
358	Service Indus Mach's	2,114	.04	5.66	1,798	.06	7.48	6.92
307	Misc Plastic Prods	9,383	.19	5.85	7,685	.25	7.73	6.34
352	Farm Mach'y or Equip	7,083	.14	5.99	6,945	.23	7.96	6.02
23	Apparel	1,774	.04	6.03	1,413	.05	8.01	5.62
229	Misc Textile Goods	5,529	.11	6.14	3,941	.13	8.14	5.47
364	Elec Lighting or Wire Equip	2,004	.04	6.18	1,980	.06	8.2	5.36
353	Const'n Mach'y or Equip	10,966	.22	6.4	10,343	.34	8.54	5.06
205	Bakery Products	2,908	.06	6.46	2,538	.08	8.62	4.89
301	Tires or Inner Tubes	17,528	.35	6.81	13,392	.44	9.06	4.85
265	Containers or Boxes, Paperbd	11,575	.23	7.04	7,441	.24	9.3	4.83

APPENDIX III-A
TABLE III-2E-2

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	CUM %	TON-MILES (THOUS)	% OF TOTAL	CUM %	CENTS PER TON-MILE
365	Radio or TV Rec. Sets	2,098	.04	7.08	2,256	.07	9.37	4.68
38	Instru. or Photo Goods	1,129	.02	7.1	1,075	.04	9.41	4.53
332	Iron or Steel Castings	19,739	.4	7.5	5,788	.19	9.6	4.50
349	Misc. Fab. Metal Prod.	6,978	.14	7.64	5,163	.17	9.77	4.39
264	Converted Paper, Etc.	54,295	1.1	8.74	38,577	1.26	11.03	4.39
31	Leather or Leather Prod.	647	.01	8.75	374	.01	11.04	4.37
339	Misc. Primary Metal Prod.	7,253	.15	8.9	3,231	.11	11.15	4.05
322	Glass or Glassware	8,165	.16	9.06	7,541	.25	11.4	4.03
374	Railroad Equip	24,676	.5	9.56	12,523	.41	11.81	4.00
227	Floor Coverings	2,627	.05	9.61	2,884	.09	11.9	3.86
344	Fab. Struct Metal Prod.	44,390	.9	10.51	30,397	.99	12.89	3.84
331	Steel Works Prod.	363,199	7.33	17.84	133,500	4.36	17.25	3.53
284	Soap or Other Detergents	14,045	.28	18.12	12,020	.39	17.64	3.48
211	Cigarettes	4,928	.1	18.22	6,689	.22	17.86	3.42
207	Confectioner or Rel. Prod.	3,317	.07	18.29	3,489	.11	17.97	3.38
201	Meat, Fresh, Chilled	36,275	.73	19.02	26,755	.87	18.84	3.38
295	Paving or Roofing Matl's	12,295	.25	19.27	5,317	.17	19.01	3.29
202	Dairy Products	12,024	.24	19.51	9,063	.3	19.31	3.23
286	Gum or Wood Chem.	7,305	.15	19.66	5,206	.17	19.48	3.09
327	Concrete, Gypsum Prod.	72,128	1.46	21.12	22,749	.74	20.22	2.96
291	Prod. of Petro Ref'g.	215,226	4.34	25.46	109,307	3.57	23.79	2.95

APPENDIX III-A
TABLE III-2E-3

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	CUM %	TON-MILES (THOUS)	% OF TOTAL	CUM %	CENTS PER TON-MILE
335	Nonferrous Metal Basic	23,311	.47	25.93	23,677	.77	24.56	2.89
289	Misc. Chem. Prod.	69,174	1.4	27.33	51,468	1.68	26.24	2.88
204	Grain Mill Products	333,332	6.73	34.06	175,030	5.71	31.95	2.87
262	Paper	112,275	2.27	36.33	89,772	2.93	34.88	2.85
282	Plastic Materials	100,353	2.03	38.36	86,778	2.83	37.71	2.82
266	Building Paper or Board	20,790	.42	38.78	17,083	.56	38.27	2.82
324	Hydraulic Cement	156,799	3.16	41.94	42,420	1.38	39.65	2.73
27	Printed Matter	2,433	.05	41.99	3,544	.12	39.77	2.66
299	Misc, Coal or Petro. Prod.	190,456	3.84	45.83	80,158	2.62	42.39	2.56
208	Beverages or Flav'g Extracts	117,050	2.36	48.19	105,834	3.45	45.84	2.53
281	Indus. Inorganic Chem.	555,607	11.21	59.4	387,439	12.64	58.48	2.53
329	Abrasives or Asbestos	244,942	4.94	64.34	137,544	4.49	62.97	2.51
263	Fiberboard, Etc.	184,772	3.73	68.07	137,147	4.48	67.45	2.48
209	Misc. Food Prep.	223,952	4.52	72.59	134,536	4.39	71.84	2.46
249	Misc. Wood Products	43,202	.87	73.46	49,362	1.61	73.45	2.42
241	Primary Forest Mat'ls	614,557	12.4	85.86	99,339	3.24	76.69	2.39
287	Agricultural Chem.	136,328	2.75	88.61	73,112	2,39	79.08	2.37
203	Canned or Pres'd Fruits	87,645	1.77	90.38	126,685	4.13	83.21	2.33
325	Struct. Clay Prod.	49,754	1.0	91.38	27,892	.91	34.12	2.32

APPENDIX III-A
TABLE III-2E-4

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	CUM %	TON-MILES (THOUS)	% OF TOTAL	CUM %	CENTS PER TON-MILE
206	Sugar, Beet or Cane	76,434	1.54	92.92	60,060	1.96	86.08	2.28
243	Millwork Products	78,303	1.58	94.5	106,607	3.48	89.56	2.26
333	Non-Ferrous Metal	64,562	1.30	95.8	72,923	2.38	91.94	2.25
242	Sawmill Products	149,614	3.01	98.81	198,001	6.46	98.4	2.21
261	Pulp or Pulp Mill Products	55,865	1.13	99.94	48,980	1.6	100	2.06

APPENDIX III-A
TABLE III-3E-1

CARLOAD WAYBILL STATISTICS
BASIC DATA - 2-DIGIT BREAKDOWN

		WEIGHT (TONS)	% OF TOTAL	TON-MILES (THOUS)	% OF TOTAL	AVG DIST (MILES)	AVERAGE REVENUE (¢) PER CWT	PER TON-MILE
Total Carload Traffic		12,557,565	100.0	5,520,056	100.0	440	58.6	2.67
STCC	DESCRIPTION							
01	Farm Products	1,191,338	9.49	582,615	10.55	489	56.3	2.30
08	Forest Products	5,589	0.04	6,137	0.11	1098	128.6	2.34
09	Fresh Fish Etc	1,023	0.01	889	0.02	869	86.2	1.98
10	Metallic Ores	1,309,789	10.43	200,327	3.63	153	18.2	2.38
11	Coal	3,142,239	25.02	1,005,114	18.21	320	26.4	1.65
13	Crude Petroleum	24,953	0.20	10,705	0.19	429	40.7	1.90
14	Nonmetallic Min'l's	1,297,126	10.33	251,140	4.55	194	21.0	2.16
19	Ordnance or Access	3,126	0.02	2,471	0.04	790	224.4	5.68
20	Food or Kindred Prod.	892,937	7.11	643,991	11.67	721	94.0	2.61
21	Tobacco Products	6,395	0.05	7,284	0.13	1139	194.2	3.41
22	Textile Mill Prod.	10,138	0.08	8,870	0.16	875	199.3	4.56
23	Apparel	1,774	0.01	1,413	0.03	797	224.1	5.62
24	Lumber or Wood Prod.	887,549	7.07	454,611	8.24	512	58.6	2.29
25	Furniture or Fixtures	13,666	0.11	11,456	0.21	838	370.1	8.83
26	Pulp, Paper or Allied Prod.	439,572	3.50	339,000	6.14	771	108.1	2.80
27	Printed Matter	2,433	0.02	3,544	0.06	1456	193.8	2.66

APPENDIX III-A
TABLE III-3E-2

		WEIGHT (TONS)	% OF TOTAL	TON-MILES (THOUS)	% OF TOTAL	AVG DIST (MILES)	AVERAGE REVENUE (¢) PER CWT	AVERAGE REVENUE (¢) PER TON-MILE
28	Chemicals or Allied Prod.	887,361	7.07	620,195	11.24	699	91.0	2.61
29	Petroleum or Coal Prods	417,977	3.33	194,783	3.53	466	65.2	2.80
30	Rubber or Misc Plastic	28,999	0.23	22,425	0.41	773	212.3	5.49
31	Leather or Leather Prod.	647	0.01	374	0.01	579	126.5	4.37
32	Clay, Concrete, Glass	537,415	4.28	242,466	4.39	451	59.7	2.65
33	Primary Metal Prod.	479,584	3.82	239,832	4.34	500	77.8	3.11
34	Fabricated Metal Prod.	64,475	0.51	42,462	0.77	659	140.4	4.26
35	Machinery	26,562	0.21	25,077	0.45	944	262.6	5.56
36	Electrical Mach'y or Equip	26,019	0.21	23,475	0.43	902	296.9	6.58
37	Transportation Equip	269,332	2.14	210,537	3.81	782	267.1	6.83
38	Instru. or Photo. Goods	1,129	0.01	1,075	0.02	952	215.5	4.53
39	Misc. Prod. of Mfrg.	3,006	0.02	3,150	0.06	1,048	339.3	6.48
40	Waste or Scrap Mat'ls	335,172	2.67	86,242	1.56	257	52.6	4.09
41	Misc. Freight Shipments	4,379	0.03	3,014	0.05	688	207.8	6.04
42	Containers, Shipping, Ret. Empty	10,699	0.09	8,369	0.15	782	128.9	3.29
44	Frt Fwdr. Traffic	28,546	0.23	45,445	0.82	1,592	228.4	2.87
45	Shipper Assoc. or Sim. Traff.	46,592	0.37	58,754	1.06	1,261	194.3	3.08
46	Misc. Mixed Shipments	159,924	1.27	162,800	2.95	1,018	150.8	2.96
		12,557,465	100.00	5,520,042	100.00			

APPENDIX III-A
TABLE III-4E-1

CARLOAD WAYBILL STATISTICS

BASIC DATA - 3-DIGIT BREAKDOWN (2-DIGIT DATA WHERE NO 3-DIGIT AVAILABLE)

		WEIGHT (TONS)	% OF TOTAL	TON-MILES (THOUS)	% OF TOTAL	AVG DIST (MILES)	AVG REVENUE (CENTS) PER CWT	PER TON-MILE
TOTAL CARLOAD TRAFFIC		12,557,565	100.0	5,520,056	100.0	440	58.6	2.67
STCC	DESCRIPTION							
011	Field Crops	1,155,751	9.20	520,006	9.42	450	50.5	2.24
012	Fresh Fruits or Tree Nuts	10,325	0.08	21,250	0.38	2058	281.8	2.74
013	Fresh Vegetables	19,769	0.16	36,761	0.67	1860	261.2	2.81
01	Total	1,185,845	9.44	578,017	10.47	-	-	-
01	Farm Products	1,191,338	9.49	582,615	10.55	489	56.3	2.30
08	Forest Products	5,589	0.04	6,137	0.11	1098	120.6	2.34
09	Fresh Fish Etc	1,023	0.01	889	0.02	869	86.2	1.98
101	Iron Ores	1,117,254	8.90	137,429	2.49	123	15.4	2.51
102	Copper Ores	75,613	0.60	12,445	0.23	165	12.9	1.57
103	Lead or Zinc Ores	22,321	0.18	8,502	0.15	381	40.0	2.10
105	Bauxite or Other Al. Ores	63,162	0.50	31,308	0.57	496	53.1	2.14
106	Manganese Ores	9,089	0.07	2,787	0.05	307	48.8	3.18
109	Misc. Metal Ores	19,893	0.16	6,369	0.12	320	41.9	2.62
10	Total	1,307,332	10.41	198,840	3.60	-	-	-
10	Metallic Ores	1,309,789	10.43	200,327	3.63	153	18.2	2.38

APPENDIX III-A
TABLE III-4E-2

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	TON-MILES (THOUS)	% OF TOTAL	AVG DIST (MILES)	AVG REVENUE (CENTS) PER CWT	PER TON-MILE
111	Anthracite	21,975	0.17	6,732	0.12	306	40.1	2.62
112	Bituminous Coal	3,120,264	24.85	998,381	18.09	320	26.3	1.64
11	Total	3,142,239	25.02	1,005,113	18.21	-	-	-
11	Coal	3,142,239	25.02	1,005,114	18.21	320	26.4	1.65
131	Crude Petroleum or N.G.	20,786	0.17	8,373	0.15	403	36.7	1.82
13	Total	20,786	0.17	8,373	0.15	-	-	-
13	Crude Petroleum	24,953	0.20	10,705	0.19	429	40.7	1.90
142	Crushed or Broken Stone	450,313	3.59	73,694	1.34	164	18.3	2.24
144	Gravel or Sand	330,329	2.63	65,291	1.18	198	25.3	2.56
145	Clay, Ceramic or Refractory	30,157	0.24	14,139	0.26	469	48.4	2.06
147	Chemical or Fert. Min'ls	431,656	3.44	65,556	1.19	152	13.6	1.79
149	Misc. Nonmetallic Min'ls	53,056	0.42	31,634	0.57	596	58.9	1.98
14	Total	1,295,511	10.32	250,314	4.53	-	-	-
14	Nonmetallic Min'ls	1,297,126	10.33	251,140	4.55	194	21.0	2.16
19	Ordnance or Access	3,126	0.02	2,471	0.04	790	224.4	5.68
201	Meat, Fresh, Chilled	36,275	0.29	26,755	0.48	738	124.7	3.38
202	Dairy Products	12,024	0.10	9,063	0.16	754	121.8	3.23
203	Canned or Pres'd Fruits	87,645	0.70	126,685	2.30	1445	168.4	2.33
204	Grain Mill Products	333,332	2.65	175,030	3.17	525	75.5	2.87
205	Bakery Products	2,908	0.02	2,538	0.05	873	213.6	4.89
206	Sugar, Beet or Cane	76,434	0.61	60,060	1.09	786	89.6	2.28
207	Confectionery or Rel.Prod.	3,317	0.03	3,489	0.06	1052	177.5	3.38
208	Beverages or Flav'g Extracts	117,050	0.93	105,834	1.92	904	114.3	2.53
209	Misc. Food Prep.	223,952	1.78	134,536	2.44	601	74.0	2.46
20	Total	892,937	7.11	643,990	11.67	-	-	-
20	Food or Kindred Prod.	892,937	7.11	643,991	11.67	721	94.0	2.61

APPENDIX III-A
TABLE III-4E-3

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	TON-MILES (THOUS)	% OF TOTAL	AVG DIST (MILES)	AVG REVENUE (CENTS) PER CWT	PER TON-MILE
211	Cigarettes	4,928	0.04	6,689	0.12	1357	232.0	3.42
21	Total	4,928	0.04	6,689	0.12	-	-	-
21	Tobacco Products	6,395	0.05	7,284	0.13	1139	194.2	3.41
227	Floor Coverings	2,627	0.02	2,884	0.05	1098	212.1	3.86
229	Misc. Textile Goods	5,529	0.04	3,941	0.07	713	195.1	5.47
22	Total	8,156	0.06	6,825	0.12	-	-	-
22	Textile Mill Prod.	10,138	0.08	8,870	0.16	875	199.3	4.56
23	Apparel	1,774	0.01	1,413	0.03	797	224.1	5.62
241	Primary Forest Mat'ls	614,557	4.89	99,339	1.80	162	19.3	2.39
242	Sawmill Products	149,614	1.19	198,001	3.59	1323	146.2	2.21
243	Millwork Products	78,303	0.62	106,607	1.93	1361	154.0	2.26
249	Misc. Wood Products	43,202	0.34	49,362	0.89	1143	138.2	2.42
24	Total	885,675	7.05	453,309	8.21	-	-	-
24	Lumber or Wood Products	887,549	7.07	454,611	8.24	512	58.6	2.29
251	Household or Off. Furn.	9,185	0.07	7,737	0.14	842	375.2	8.91
259	Misc. Furn. or Fixtures	3,067	0.02	2,634	0.05	859	389.6	9.07
25	Total	12,252	0.10	10,371	0.19	-	-	-
25	Furniture or Fixtures	13,666	0.11	11,456	0.21	838	370.1	8.83

APPENDIX III-A
TABLE III-4E-4

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	TON-MILES (THOUS)	% OF TOTAL	AVG DIST (MILES)	AVG REVENUE (CENTS) PER CWT	PER TON-MILE
261	Pulp or Pulp Mill Prods	55,865	0.44	48,980	0.89	877	90.5	2.06
262	Paper	112,275	0.89	89,772	1.63	800	113.8	2.85
263	Fiberboard Etc.	184,772	1.47	137,147	2.48	742	92.1	2.48
264	Converted Paper Etc.	54,295	0.43	38,577	0.70	692	155.8	4.39
265	Containers or Boxes, Paperbd	11,575	0.09	7,441	0.13	643	155.4	4.83
266	Building Paper or Board	20,790	0.17	17,083	0.31	822	115.9	2.82
26	Total	439,572	3.50	339,000	6.14	-	-	-
26	Pulp, Paper, or Allied Prod.	439,572	3.50	339,000	6.14	771	108.1	2.80
27	Printed Matter	2,433	0.02	3,544	0.06	1456	193.8	2.66
281	Indus Inorganic Chem	555,607	4.42	387,439	7.02	697	88.1	2.53
282	Plastic Materials	100,353	0.80	86,778	1.57	865	121.8	2.82
284	Soap or Oth Detergents	14,045	0.11	12,020	0.22	856	149.1	3.48
286	Gum or Wood Chem.	7,305	0.06	5,206	0.09	713	110.1	3.09
287	Agricultural Chem.	136,328	1.09	73,112	1.32	536	63.5	2.37
289	Misc Chem Prod.	69,174	0.55	51,468	0.93	744	107.1	2.88
28	Total	882,812	7.03	616,023	11.16	-	-	-
28	Chemicals or Allied Prod.	887,361	7.07	620,195	11.24	699	91.0	2.61
291	Products of Petro Ref'g	215,226	1.71	109,307	1.98	508	74.9	2.95
295	Paving or Roofing Mat'ls	12,295	0.10	5,317	0.10	432	71.2	3.29
299	Misc. Coal or Petro. Prod.	190,456	1.52	80,158	1.45	421	53.9	2.56
29	Total	417,977	3.33	194,782	3.53	-	-	-
29	Petroleum or Coal Prod.	417,977	3.33	194,783	3.53	466	65.2	2.80

APPENDIX III-A
TABLE III-4E-5

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	TON-MILES (THOUS)	% OF TOTAL	AVG DIST (MILES)	AVG REVENUE (CENTS) PER CWT	AVG REVENUE (CENTS) PER TON-MILE
301	Tires or Inner Tubes	17,528	0.14	13,392	0.24	764	185.3	4.85
306	Misc. Fabricated Rubber	1,579	0.01	1,083	0.02	686	270.7	7.89
307	Misc. Plastic Prod.	9,383	0.07	7,685	0.14	819	259.5	6.34
30	Total	28,490	0.23	22,160	0.40	-	-	-
30	Rubber or Misc Plastic	28,999	0.23	22,425	0.41	773	212.3	5.49
31	Leather or Leather Prod.	647	0.01	374	0.01	579	126.5	4.37
322	Glass or Glassware	8,165	0.07	7,541	0.14	924	186.0	4.03
324	Hydraulic Cement	156,799	1.25	42,420	0.77	271	36.9	2.73
325	Struct. Clay Prod.	49,754	0.40	27,892	0.51	561	65.1	2.32
327	Concrete, Gypsum Prod.	72,128	0.57	22,749	0.41	315	46.7	2.96
329	Abrasives or Asbestos	244,942	1.95	137,544	2.49	562	70.4	2.51
32	Total	531,788	4.23	238,146	4.31	-	-	-
32	Clay, Concrete, Glass	537,415	4.28	242,466	4.39	451	59.7	2.65
331	Steel Works Prod.	363,199	2.89	133,500	2.42	368	64.9	3.53
332	Iron or Steel Castings	19,739	0.16	5,788	0.10	293	66.0	4.50
333	Non Ferrous Metal	64,562	0.51	72,923	1.32	1130	126.8	2.25
335	Non Ferrous Metal Basic	23,311	0.19	23,677	0.43	1016	146.9	2.89
339	Misc. Primary Metal Prod.	7,253	0.06	3,231	0.06	445	90.3	4.05
33	Total	478,064	3.81	239,119	4.33	-	-	-
33	Primary Metal Prod.	479,584	3.82	239,832	4.34	500	77.8	3.11
341	Metal Cans	3,013	0.02	2,153	0.04	715	310.7	8.70
344	Fab Struct. Metal Prod.	49,390	0.39	30,397	0.55	615	118.2	3.84
349	Misc. Fab. Metal Prod.	6,978	0.06	5,163	0.09	740	162.4	4.39
34	Total	59,381	0.47	37,713	0.68	-	-	-
34	Fabricated Metal Prod.	64,475	0.51	42,462	0.77	659	140.4	4.26

APPENDIX III-A
TABLE III-4E-6

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	TON-MILES (THOUS)	% OF TOTAL	AVG DIST (MILES)	AVG REVENUE (CENTS) PER CWT	AVG REVENUE (CENTS) PER TON-MILE
352	Farm Mach'y or Equip.	7,083	0.06	6,945	0.13	981	295.3	6.02
353	Const'n Mach'y or Equip.	10,966	0.09	10,343	0.19	943	238.5	5.06
358	Service Indus. Mach's.	2,114	0.02	1,798	0.03	851	294.4	6.92
35	Total	20,163	0.16	19,086	0.35	-	-	-
35	Machinery	26,562	0.21	25,077	0.45	944	262.6	5.56
363	Household Appliances	17,064	0.14	14,977	0.27	878	322.3	7.34
364	Elec. Lighting or Wire Equip	2,004	0.02	1,980	0.04	988	264.6	5.36
365	Radio or TV Rec. Sets	2,098	0.02	2,256	0.04	1075	251.3	4.68
36	Total	21,166	0.17	19,213	0.35	-	-	-
36	Elec. Mach'y or Equip.	26,019	0.21	23,475	0.43	902	296.9	6.58
371	Motor Vehicles	243,228	1.94	196,767	3.56	809	283.7	7.01
374	Railroad Equip.	24,676	0.20	12,523	0.23	507	101.5	4.00
37	Total	267,904	2.13	209,290	3.79	-	-	-
37	Transportation Equip.	269,332	2.14	210,537	3.81	782	267.1	6.83
38	Instru. or Photo. Goods	1,129	0.01	1,075	0.02	952	215.5	4.53
394	Toys, Amuse, or Sport. Goods	2,025	0.02	1,878	0.03	927	347.8	7.50
39	Total	2,025	0.02	1,878	0.03	-	-	-
39	Misc. Prod. of Mfrg	3,006	0.02	3,150	0.06	1048	339.3	6.48
402	Waste or Scrap	334,763	2.67	86,060	1.56	257	52.6	4.10
40	Total	334,763	2.67	86,060	1.56	-	-	-
40	Waste or Scrap Mat'ls	335,172	2.67	86,242	1.56	257	52.6	4.09

APPENDIX III-A
TABLE III-4E-7

STCC	DESCRIPTION	WEIGHT (TONS)	% OF TOTAL	TON-MILES (THOUS)	% OF TOTAL	AVG DIST (MILES)	AVG REVENUE (CENTS)	
							PER CWT	PER TON-MILE
411	Misc. Freight Shipments	3,760	0.03	2,803	0.05	745	233.3	6.26
41	Total	3,760	0.03	2,803	0.05	-	-	-
41	Misc. Freight Shipments	4,379	0.03	3,014	0.05	688	207.8	6.04
421	Cont. Ship'g Ret. Empty	6,676	0.05	5,716	0.10	856	158.8	3.71
422	Trailers, Semi's, Ret. Empty	4,023	0.03	2,653	0.05	660	79.1	2.40
42	Total	10,699	0.09	8,369	0.15	-	-	-
42	Containers, Shipping, Ret. Empty	10,699	0.09	8,369	0.15	782	128.9	3.29
441	Frt Fwdr Traffic	28,546	0.23	45,445	0.82	1592	228.4	2.87
44	Total	28,546	0.23	45,445	0.82	-	-	-
44	Frt Fwdr Traffic	28,546	0.23	45,445	0.82	1592	228.4	2.87
451	Shipper Assoc or Sim. Traff.	46,592	0.37	58,754	1.06	1261	194.3	3.08
45	Total	46,592	0.37	58,754	1.06	-	-	-
45	Shipper Assoc or Sim. Traff.	46,592	0.37	58,754	1.06	1261	194.3	3.08
461	Misc. Mixed Shipments	159,167	1.27	161,957	2.93	1018	150.5	2.96
46	Total	159,167	1.27	161,957	2.93	-	-	-
46	Misc. Mixed Shipments	159,924	1.27	162,800	2.95	1018	150.8	2.96

APPENDIX III-A
TABLE III-1M-1

CARLOAD WAYBILL STATISTICS
ALL COMMODITIES - RANKED BY REVENUE PER TON-MILE

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	CUM %	METRIC TON-KM (THOUS)	% OF TOTAL	CUM %	CENTS PER METRIC TON-KM
259	Misc Furn. or Fixtures	2,782	0.02	0.02	3,846	0.05	0.05	6.21
251	Household or Off. Furn.	8,332	0.07	0.09	11,296	0.14	0.19	6.10
341	Metal Cans	2,733	0.02	0.11	3,143	0.04	0.23	5.96
306	Misc Fabricated Rubber	1,432	0.01	0.12	1,581	0.02	0.25	5.40
394	Toys, Amuse or Sport. Goods	1,837	0.02	0.14	2,742	0.03	0.28	5.14
363	Household Appliances	15,480	0.14	.28	21,866	0.27	0.55	5.03
371	Motor Vehicles	220,653	1.94	2.22	287,274	3.56	4.11	4.80
358	Service Indus Mach's	1,918	0.02	2.24	2,625	0.03	4.14	4.74
307	Misc Plastic Prods	8,512	0.07	2.31	11,220	0.14	4.28	4.34
411	Misc Freight Shipments	3,411	0.03	2.34	4,092	0.05	4.33	4.29
352	Farm Machinery or Equipment	6,426	0.06	2.4	10,140	0.13	4.46	4.12
19	Ordnance or Access	2,836	0.02	2.42	3,608	0.04	4.5	3.89
23	Apparel	1,609	0.01	2.43	2,063	0.03	4.53	3.85
229	Misc Textile Goods	5,016	0.04	2.47	5,754	0.07	4.6	3.75
364	Elec Lighting or Wire Equip	1,818	0.02	2.49	2,891	0.04	4.64	3.67
353	Const'n Mach'y or Equip	9,948	0.09	2.58	15,100	0.19	4.83	3.47
205	Bakery Products	2,638	0.02	2.6	3,705	0.05	4.88	3.35

APPENDIX III-A
TABLE III-1M-2

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	CUM %	METRIC TON-KM (THOUS)	% OF TOTAL	CUM %	CENTS PER METRIC TON-KM
301	Tires or Inner Tubes	15,901	0.14	2.74	19,552	0.24	5.12	3.32
265	Containers or Boxes, Paperbd	10,501	0.09	2.83	10,864	0.13	5.25	3.31
365	Radio or TV Rec. Sets	1,903	0.02	2.85	3,294	0.04	5.29	3.21
38	Instru. or Photo Goods	1,024	0.01	2.86	1,569	0.02	5.31	3.10
332	Iron or Steel Castings	17,907	0.16	3.02	8,450	0.10	5.41	3.08
349	Misc. Fab. Metal Prod.	6,330	0.06	3.08	7,538	0.09	5.5	3.01
264	Converted Paper, Etc.	49,256	0.43	3.51	56,321	0.70	6.2	3.01
31	Leather or Leather Prod.	587	0.01	3.52	546	0.01	6.21	2.99
402	Waste or Scrap	303,692	2.67	6.19	125,645	1.56	7.77	2.81
339	Misc. Primary Metal Prod.	6,580	0.06	6.25	4,717	0.06	7.83	2.77
322	Glass or Glassware	7,407	0.07	6.32	11,010	0.14	7.97	2.76
374	Railroad Equip	22,386	0.20	6.52	18,283	0.23	8.2	2.74
227	Floor Coverings	2,383	0.02	6.54	4,211	0.05	8.25	2.64
344	Fab. Struct Metal Prod.	40,270	0.39	6.93	44,379	0.55	8.8	2.63
421	Cont. Ship'g, Ret. Empty	6,056	0.05	6.98	8,345	0.10	8.9	2.54
331	Steel Works Prod.	329,489	2.89	9.87	194,906	2.42	11.32	2.42
284	Soap or Other Detergents	12,741	0.11	9.98	17,549	0.22	11.54	2.38
211	Cigarettes	4,471	0.04	10.02	9,766	0.12	11.66	2.34
207	Confectioner or Rel. Prod.	3,009	0.03	10.05	5,094	0.06	11.72	2.32

APPENDIX III-A
TABLE III-1M-3

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	CUM %	METRIC TON-KM (THOUS)	% OF TOTAL	CUM %	CENTS PER METRIC TON-KM
201	Meat, Fresh, Chilled	32,908	0.29	10.34	39,062	0.48	12.2	2.32
295	Paving or Roofing Mat'ls	11,154	0.10	10.44	7,763	0.10	12.3	2.25
202	Dairy Products	10,908	0.10	10.54	13,232	0.16	12.46	2.21
106	Manganese Ores	8,245	0.07	10.61	4,069	0.05	12.51	2.18
286	Gum or Wood Chem.	6,627	0.06	10.67	7,601	0.09	12.6	2.12
451	Shipper Assoc or Sim. Traff.	42,268	0.37	11.04	85,779	1.06	13.66	2.11
327	Concrete, Gypsum Prod.	65,433	0.57	11.61	33,213	0.41	14.07	2.03
461	Misc Mixed Shipments	144,394	1.27	12.88	236,453	2.93	17.00	2.03
291	Prod. of Petro Ref'g.	195,250	1.71	14.59	159,585	1.98	18.98	2.02
335	Nonferrous Metal Basic	21,147	0.19	14.78	34,568	0.43	19.41	1.98
289	Misc. Chem. Prod.	62,754	0.55	15.33	75,142	0.93	20.34	1.97
204	Grain Mill Products	302,394	2.65	17.98	255,539	3.17	23.51	1.97
441	Frt Fwdr. Traffic	25,896	0.23	18.21	66,348	0.82	24.33	1.97
262	Paper	101,854	0.89	19.1	131,065	1.63	25.96	1.95
282	Plastic Materials	91,039	0.80	19.9	126,693	1.57	27.53	1.93
266	Building Paper or Board	18,860	0.17	20.07	24,941	0.31	27.84	1.93
013	Fresh Vegetables	17,934	0.16	20.23	53,670	0.67	28.51	1.92
012	Fresh Fruits or Tree Nuts	9,367	0.08	20.31	31,024	0.38	28.89	1.88
324	Hydraulic Cement	142,246	1.25	21.56	61,932	0.77	29.66	1.87

APPENDIX III-A
TABLE III-1M-4

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	CUM %	METRIC TON-KM (THOUS)	% OF TOTAL	CUM %	CENTS PER METRIC TON-KM
27	Printed Matter	2,207	0.02	21.58	5,174	0.06	29.72	1.82
109	Misc. Metal Ores	18,047	0.16	21.74	9,299	0.12	29.84	1.79
111	Anthracite	19,935	0.17	21.91	9,829	0.12	29.96	1.79
144	Gravel or Sand	299,669	2.63	24.54	95,323	1.18	31.14	1.75
299	Misc. Coal or Petro. Prod.	172,779	1.52	26.06	117,028	1.45	32.59	1.75
208	Beverages or Flav'g Extracts	106,186	0.93	26.99	154,515	1.92	34.51	1.73
281	Indus. Inorganic Chem.	507,038	4.42	31.41	565,650	7.02	41.53	1.73
329	Abrasives or Asbestos	222,208	1.95	33.36	200,810	2.49	44.02	1.72
101	Iron Ores	1,013,556	8.90	42.26	200,643	2.49	46.51	1.72
263	Fiberboard, Etc.	167,622	1.47	43.73	200,231	2.48	48.99	1.70
209	Misc. Food Prep.	203,166	1.78	45.51	196,419	2.44	51.43	1.68
249	Misc. Wood Products	39,192	0.34	45.85	72,067	0.89	52.32	1.66
422	Trailers, Semi's, Ret. Empty	3,650	0.03	45.88	3,873	0.05	52.37	1.64
241	Primary Forest Matl's	557,517	4.89	50.77	145,032	1.80	54.17	1.64
287	Agricultural Chem.	123,675	1.09	51.86	106,741	1.32	55.49	1.62
08	Forest Products	5,070	0.04	51.9	8,960	0.11	55.6	1.60
203	Canned or Pres'd Fruits	79,510	0.70	52.6	184,957	2.30	57.9	1.60
325	Struct. Clay Prod.	45,136	0.40	53.0	40,722	0.51	58.41	1.59
206	Sugar, Beet or Cane	69,340	0.61	53.61	87,686	1.09	59.5	1.56

APPENDIX III-A
TABLE III-1M-5

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	CUM %	METRIC TON-KM (THOUS)	% OF TOTAL	CUM %	CENTS PER METRIC TON-KM
243	Millwork Products	71,035	0.62	54.23	155,643	1.93	61.43	1.55
333	Non-Ferrous Metal	58,570	0.51	54.74	106,466	1.32	62.75	1.54
142	Crushed or Broken Stone	416,682	3.59	58.33	107,591	1.34	64.09	1.53
011	Field Crops	1,048,480	9.20	67.53	759,194	9.42	73.51	1.53
242	Sawmill Products	135,728	1.19	68.72	289,076	3.59	77.1	1.51
105	Bauxite or Other Al. Ores	57,300	0.50	69.22	45,709	0.57	77.67	1.47
103	Lead or Zinc Ores	20,249	0.18	69.4	12,413	0.15	77.82	1.44
261	Pulp or Pulp Mill Prod.	50,680	0.44	69.84	71,509	0.89	78.71	1.41
145	Clay, Ceramic or Refractory	27,358	0.24	70.08	20,643	0.26	78.97	1.41
149	Misc. Nonmetallic Min'ls	48,132	0.42	70.5	46,185	0.57	79.54	1.36
09	Fresh Fish, Etc.	928	0.01	70.51	1,298	0.02	79.56	1.36
131	Crude Petroleum or N.G.	18,857	0.17	70.68	12,224	0.15	79.71	1.25
147	Chemical or Fert. Min'ls	391,592	3.44	74.12	95,710	1.19	80.9	1.23
112	Bituminous Coal	2,830,656	24.85	98.97	1,457,609	18.09	98.99	1.12
102	Copper Ores	68,595	0.60	99.57	18,169	0.23	99.22	1.08

APPENDIX III-A
TABLE III-2M-1

CARLOAD WAYBILL STATISTICS

MANUFACTURED GOODS - RANKED BY REVENUE PER TON-MILE

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	CUM %	METRIC TON-KM (THOUS)	% OF TOTAL	CUM %	CENTS PER METRIC TON-KM
259	Misc Furn. or Fixtures	2,782	.06	.06	3,846	.09	.09	6.21
251	Household or Off. Furn.	8,332	.19	.25	11,296	.25	.34	6.10
341	Metal Cans	2,733	.06	.31	3,143	.07	.41	5.96
306	Misc Fabricated Rubber	1,432	.03	.34	1,581	.04	.45	5.40
394	Toys, Amuse or Sport Goods	1,837	.04	.38	2,742	.06	.51	5.14
363	Household Appliances	15,480	.34	.72	21,866	.49	1.0	5.03
371	Motor Vehicles	220,653	4.9	5.62	287,274	6.42	7.42	4.80
358	Service Indus Mach's	1,918	.04	5.66	2,625	.06	7.48	4.74
307	Misc Plastic Prods	8,512	.19	5.85	11,220	.25	7.73	4.34
352	Farm Mach'y or Equip	6,426	.14	5.99	10,140	.23	7.96	4.12
23	Apparel	1,609	.04	6.03	2,063	.05	8.01	3.85
229	Misc Textile Goods	5,016	.11	6.14	5,754	.13	8.14	3.75
364	Elec Lighting or Wire Equip	1,818	.04	6.18	2,891	.06	8.2	3.67
353	Const'n Mach'y or Equip	9,948	.22	6.4	15,100	.34	8.54	3.47
205	Bakery Products	2,638	.06	6.46	3,705	.08	8.62	3.35
301	Tires or Inner Tubes	15,901	.35	6.81	19,552	.44	9.06	3.32
265	Containers or Boxes, Paperbd	10,501	.23	7.04	10,864	.24	9.3	3.31

APPENDIX III-A
TABLE III-2M-2

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	CUM %	METRIC TON-KM (THOUS)	% OF TOTAL	CUM %	CENTS PER METRIC TON-KM
365	Radio or TV Rec. Sets	1,903	.04	7.08	3,294	.07	9.37	3.21
38	Instru. or Photo Goods	1,024	.02	7.1	1,569	.04	9.41	3.10
332	Iron or Steel Castings	17,907	.4	7.5	8,450	.19	9.6	3.08
349	Misc. Fab. Metal Prod.	6,330	.14	7.64	7,538	.17	9.77	3.01
264	Converted Paper, Etc.	49,256	1.1	8.74	56,321	1.26	11.03	3.01
31	Leather or Leather Prod.	587	.01	8.75	546	.01	11.04	2.99
339	Misc. Primary Metal Prod.	6,580	.15	8.9	4,717	.11	11.15	2.77
322	Glass or Glassware	7,407	.16	9.06	11,010	.25	11.4	2.76
374	Railroad Equip	22,386	.5	9.56	18,283	.41	11.81	2.74
227	Floor Coverings	2,383	.05	9.61	4,211	.09	11.9	2.64
344	Fab. Struct Metal Prod.	40,270	.9	10.51	44,379	.99	12.89	2.63
331	Steel Works Prod.	329,489	7.33	17.84	194,906	4.36	17.25	2.42
284	Soap or Other Detergents	12,741	.28	18.12	17,549	.39	17.64	2.38
211	Cigarettes	4,471	.1	18.22	9,766	.22	17.86	2.34
207	Confectioner or Rel. Prod.	3,009	.07	18.29	5,094	.11	17.97	2.32
201	Meat, Fresh, Chilled	32,908	.73	19.02	39,062	.87	18.84	2.32
295	Paving or Roofing Matl's	11,154	.25	19.27	7,763	.17	19.01	1.57
202	Dairy Products	10,908	.24	19.51	13,232	.3	19.31	2.21
286	Gum or Wood Chem.	6,627	.15	19.66	7,601	.17	19.48	2.12
327	Concrete, Gypsum Prod.	65,433	1.46	21.12	33,213	.74	20.22	2.03
291	Prod. of Petro Ref'g.	195,250	4.34	25.46	159,585	3.57	23.79	2.02

APPENDIX III-A
TABLE III-2M-3
TABLE III

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	CUM %	METRIC TON-KM (THOUS)	% OF TOTAL	CUM %	CENTS PER METRIC TON-KM
335	Nonferrous Metal Basic	21,147	.47	25.93	34,568	.77	24.56	1.98
289	Misc. Chem. Prod.	62,754	1.4	27.33	75,142	1.68	26.24	1.97
204	Grain Mill Products	302,394	6.73	34.06	255,539	5.71	31.95	1.97
262	Paper	101,854	2.27	36.33	131,065	2.93	34.88	1.95
282	Plastic Materials	91,039	2.03	38.36	126,693	2.83	37.71	1.93
266	Building Paper or Board	18,860	.42	38.78	24,941	.56	38.27	1.93
324	Hydraulic Cement	142,246	3.16	41.94	61,932	1.38	39.65	1.87
27	Printed Matter	2,207	.05	41.99	5,174	.12	39.77	1.82
299	Misc, Coal or Petro. Prod.	172,779	3.84	45.83	117,028	2.62	42.39	1.75
208	Beverages or Flav'g Extracts	106,186	2.36	48.19	154,515	3.45	45.84	1.73
281	Indus. Inorganic Chem.	504,038	11.21	59.4	565,650	12.64	58.48	1.73
329	Abrasives or Asbestos	222,208	4.94	64.34	200,810	4.49	62.97	1.72
263	Fiberboard, Etc.	167,622	3.73	68.07	200,231	4.48	67.45	1.70
209	Misc. Food Prep.	203,166	4.52	72.59	196,419	4.39	71.84	1.68
249	Misc. Wood Products	39,192	.87	73.46	72,067	1.61	73.45	1.66
241	Primary Forest Mat'ls	557,517	12.4	85.86	145,032	3.24	76.69	1.64
287	Agricultural Chem.	123,675	2.75	88.61	106,741	2.39	79.08	1.62
203	Canned or Pres'd Fruits	79,510	1.77	90.38	184,957	4.13	83.21	1.60
325	Struct. Clay Prod.	45,136	1.0	91.38	40,722	.91	84.12	1.59

APPENDIX III-A
TABLE III-2M-4

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	CUM %	METRIC TON-KM (THOUS)	% OF TOTAL	CUM %	CENTS PER METRIC TON-KM
206	Sugar, Beet or Cane	69,340	1.54	92.92	87,686	1.96	86.08	1.56
243	Millwork Products	71,035	1.58	94.5	155,643	3.48	89.56	1.55
333	Non-Ferrous Metal	58,570	1.30	95.8	106,466	2.38	91.94	1.54
242	Sawmill Products	135,728	3.01	98.81	289,076	6.46	98.4	1.51
261	Pulp or Pulp Mill Products	50,680	1.13	99.94	71,509	1.6	100	1.41

APPENDIX III-A
TABLE III-3M-1

CARLOAD WAYBILL STATISTICS
BASIC DATA – 2-DIGIT BREAKDOWN

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	M. TON-KM (THOUS)	% OF TOTAL	AVG DIST KM	AVG REVENUE (¢) PER KG	AVG REVENUE (¢) PER M. TON-KM
	Total Carload Traffic	11,392,031	100.0	8,059,129	100.0	708	0.266	1.83
01	Farm Products	1,080,764	9.49	850,602	10.55	787	0.255	1.58
08	Forest Products	5,070	0.04	8,960	0.11	1767	0.583	1.60
09	Fresh Fish Etc	928	0.01	1,298	0.02	1399	0.391	1.36
10	Metallic Ores	1,188,221	10.43	292,472	3.63	246	0.083	1.63
11	Coal	2,850,591	25.02	1,467,439	18.21	515	0.120	1.13
13	Crude Petroleum	22,637	0.20	15,629	0.19	690	0.185	1.30
14	Nonmetallic Min'l's	1,176,733	10.33	366,657	4.55	312	0.095	1.48
19	Ordnance or Access	2,836	0.02	3,608	0.04	1271	1.018	3.89
20	Food or Kindred Prod.	810,059	7.11	940,209	11.67	1160	0.426	1.79
21	Tobacco Products	5,801	0.05	10,634	0.13	1833	0.881	2.34
22	Textile Mill Prod.	9,197	0.08	12,950	0.16	1408	0.904	3.12
23	Apparel	1,609	0.01	2,063	0.03	1283	1.017	3.85
24	Lumber or Wood Prod.	805,171	7.07	663,719	8.24	824	0.266	1.57
25	Furniture or Fixtures	12,398	0.11	16,725	0.21	1349	1.679	6.05
26	Pulp, Paper or Allied Prod.	398,773	3.50	494,931	6.14	1241	0.490	1.92
27	Printed Matter	2,207	0.02	5,174	0.06	2343	0.879	1.82

APPENDIX III-A
TABLE III-3M-2

		WEIGHT (METRIC TONS)	% OF TOTAL	M.TON-KM (THOUS)	% OF TOTAL	AVG DIST KM	AVG. REVENUE (¢) PER KG	PER M.TON-KM
28	Chemicals or Allied Prod.	805,000	7.07	905,468	11.24	1125	0.413	1.79
29	Petroleum or Coal Prods	379,182	3.33	284,378	3.53	750	0.296	1.92
30	Rubber or Misc Plastic	26,307	0.23	32,740	0.41	1244	0.963	2.76
31	Leather or Leather Prod.	587	0.01	546	0.01	932	0.574	2.99
32	Clay, Concrete, Glass	487,535	4.28	353,994	4.39	726	0.271	1.82
33	Primary Metal Prod.	435,071	3.82	350,148	4.34	802	0.353	2.13
34	Fabricated Metal Prod.	58,491	0.51	61,993	0.77	1061	0.637	2.92
35	Machinery	24,097	0.21	36,612	0.45	1519	1.191	3.81
36	Electrical Mach'y or Equip	23,604	0.21	34,273	0.43	1452	1.347	4.51
37	Transportation Equip	244,334	2.14	307,378	3.81	1259	1.212	4.68
38	Instru. or Photo. Goods	1,024	0.01	1,569	0.02	1532	0.977	3.10
39	Misc. Prod. of Mfrg.	2,727	0.02	4,599	0.06	1687	1.539	4.44
40	Waste or Scrap Mat'ls	304,063	2.67	125,911	1.56	414	0.239	2.80
41	Misc. Freight Shipments	3,973	0.03	4,400	0.05	1107	0.943	4.14
42	Containers, Shipping, Ret. Empty	9,706	0.09	12,219	0.15	1259	0.585	2.25
44	Frt Fwdr. Traffic	25,896	0.23	66,348	0.82	2562	1.036	1.97
45	Shipper Assoc. or Sim. Traff.	42,268	0.37	85,779	1.06	2029	0.881	2.11
46	Misc. Mixed Shipments	145,081	1.27	237,683	2.95	1638	0.684	2.03
		11,391,941	100.00	8,059,108	100.00			

APPENDIX III-A
TABLE III-4M-1

CARLOAD WAYBILL STATISTICS

BASIC DATA - 3-DIGIT BREAKDOWN (2-DIGIT DATA WHERE NO 3-DIGIT AVAILABLE)

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	M. TON-KM (THOUS)	% OF TOTAL	AVG DIST KM	AVG REVENUE (CENTS) PER KG	AVG REVENUE (CENTS) PER M. TON-KM
TOTAL CARLOAD TRAFFIC		11,392,031	100.0	8,059,129	100.0	708	0.266	1.83
011	Field Crops	1,048,480	9.20	759,194	9.42	724	0.229	1.53
012	Fresh Fruits or Tree Nuts	9,367	0.08	31,024	0.38	3312	1.278	1.88
013	Fresh Vegetables	17,934	0.16	53,670	0.67	2993	1.185	1.92
01	Total	1,075,780	9.44	843,889	10.47	-	-	-
01	Farm Products	1,080,764	9.49	850,602	10.55	787	0.255	1.58
08	Forest Products	5,070	0.04	8,960	0.11	1767	0.547	1.60
09	Fresh Fish, Etc	928	0.01	1,298	0.02	1399	0.391	1.36
101	Iron Ores	1,013,556	8.90	200,643	2.49	198	0.070	1.72
102	Copper Ores	68,595	0.60	18,169	0.23	266	0.059	1.08
103	Lead or Zinc Ores	20,249	0.18	12,413	0.15	613	0.181	1.44
105	Bauxite or Other Al. Ores	57,300	0.50	45,709	0.57	798	0.241	1.47
106	Manganese Ores	8,245	0.07	4,069	0.05	494	0.221	2.18
109	Misc. Metal Ores	18,047	0.16	9,299	0.12	515	0.190	1.79
10	Total	1,185,992	10.41	290,301	3.60	-	-	-
10	Metallic Ores	1,188,221	10.43	292,472	3.63	246	0.083	1.63

APPENDIX III-A
TABLE III-4M-2

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	M. TON KM (THOUS)	% OF TOTAL	AVG DIST KM	AVG REVENUE (CENTS) PER KG	AVG REVENUE (CENTS) PER M. TON-KM
111	Anthracite	19,935	0.17	9,829	0.12	492	0.182	1.79
112	Bituminous Coal	2,830,656	24.85	1,457,609	18.09	515	0.119	1.12
11	Total	2,850,591	25.02	1,467,437	18.21	-	-	-
11	Coal	2,850,591	25.02	1,467,439	18.21	515	0.120	1.13
131	Crude Petroleum or N.G.	18,857	0.17	12,224	0.15	649	0.166	1.25
13	Total	18,857	0.17	12,224	0.15	-	-	-
13	Crude Petroleum	22,637	0.20	15,629	0.19	690	0.185	1.30
142	Crushed or Broken Stone	408,517	3.59	107,591	1.34	264	0.083	1.53
144	Gravel or Sand	299,669	2.63	95,323	1.18	319	0.115	1.75
145	Clay, Ceramic or Refractory	27,358	0.24	20,643	0.26	755	0.220	1.41
147	Chemical or Fert. Min'ls	391,592	3.44	95,710	1.19	245	0.062	1.23
149	Misc. Nonmetallic Min'ls	48,132	0.42	46,185	0.57	959	0.267	1.36
14	Total	1,175,268	10.32	365,452	4.53	-	-	-
14	Nonmetallic Min'ls	1,176,733	10.33	366,657	4.55	312	0.095	1.48
19	Ordnance or Access	2,836	0.02	3,608	0.04	1271	1.018	3.89
201	Meat, Fresh, Chilled	32,908	0.29	39,062	0.48	1188	0.566	2.32
202	Dairy Products	10,908	0.10	13,232	0.16	1213	0.552	2.21
203	Canned or Pres'd Fruits	79,510	0.70	184,957	2.30	2326	0.764	1.60
204	Grain Mill Products	302,394	2.65	255,539	3.17	845	0.342	1.97
205	Bakery Products	2,638	0.02	3,705	0.05	1405	0.969	3.35
206	Sugar, Beet or Cane	69,340	0.61	87,686	1.09	1265	0.406	1.56
207	Confectionery or Rel. Prod.	3,007	0.03	5,094	0.06	1693	0.805	2.32
208	Beverages or Flav'g Extracts	106,186	0.93	154,515	1.92	1455	0.518	1.73
209	Misc. Food Prep.	203,166	1.78	196,419	2.44	967	0.336	1.68
20	Total	810,059	7.11	940,208	11.67	-	-	-
20	Food or Kindred Prod.	810,059	7.11	940,209	11.67	1160	0.426	1.79

APPENDIX III-A
TABLE III-4M-3

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	M. TON KM (THOUS)	% OF TOTAL	AVG DIST KM	AVG REVENUE (CENTS)	
							PER KG	PER M. TON-KM
211	Cigarettes	4,471	0.04	9,766	0.12	2184	1.052	2.34
21	Total	4,471	0.04	9,766	0.12	-	-	-
21	Tobacco Products	5,801	0.05	10,634	0.13	1833	0.881	2.34
227	Floor Coverings	2,383	0.02	4,211	0.05	1767	0.962	2.64
229	Misc. Textile Goods	5,016	0.04	5,754	0.07	1147	0.885	3.75
22	Total	7,399	0.06	9,964	0.12	-	-	-
22	Textile Mill Prod.	9,197	0.08	12,950	0.16	1408	0.904	3.12
23	Apparel	1,609	0.01	2,063	0.03	1283	1.017	3.85
241	Primary Forest Mat'ls	557,517	4.89	145,032	1.80	261	0.088	1.64
242	Sawmill Products	135,728	1.19	289,076	3.59	2129	0.663	1.51
243	Millwork Products	71,035	0.62	155,643	1.93	2190	0.699	1.55
249	Misc. Wood Products	39,192	0.34	72,067	0.89	1839	0.627	1.66
24	Total	803,471	7.05	661,819	8.21	-	-	-
24	Lumber or Wood Products	805,171	7.07	663,719	8.24	824	0.266	1.57
251	Household or Off. Furn.	8,332	0.07	11,296	0.14	1355	1.702	6.10
259	Misc. Furn. or Fixtures	2,782	0.02	3,846	0.05	1382	1.767	6.21
25	Total	11,115	0.10	15,141	0.19	-	-	-
25	Furniture of Fixtures	12,398	0.11	16,725	0.21	1349	1.679	6.05

APPENDIX III-A
TABLE III-4M-4

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	M. TON-KM (THOUS)	% OF TOTAL	AVG DIST KM	AVG REVENUE (CENTS) PER KG	AVG REVENUE (CENTS) PER M. TON-KM
261	Pulp or Pulp Mill Prod.	50,680	0.44	71,509	0.89	1411	0.411	1.41
262	Paper	101,854	0.89	131,065	1.63	1287	0.516	1.95
263	Fiberboard Etc.	167,622	1.47	200,231	2.48	1194	0.418	1.70
264	Converted Paper Etc.	49,256	0.43	56,321	0.70	1114	0.707	3.01
265	Containers or Boxes, Paperbd	10,501	0.09	10,864	0.13	1035	0.705	3.31
266	Building Paper or Board	18,860	0.17	24,941	0.31	1323	0.526	1.93
26	Total	398,773	3.50	494,931	6.14	-	-	-
26	Pulp, Paper, or Allied Prod.	398,773	3.50	494,931	6.14	1241	0.490	1.92
27	Printed Matter	2,207	0.02	5,174	0.06	2343	0.879	1.82
281	Indus Inorganic Chem	504,038	4.42	565,650	7.02	1122	0.400	1.73
282	Plastic Materials	91,039	0.80	126,693	1.57	1392	0.552	1.93
284	Soap or Oth Detergents	12,741	0.11	17,549	0.22	1378	0.676	2.38
286	Gum or Wood Chem.	6,627	0.06	7,601	0.09	1147	0.499	2.12
287	Agricultural Chem.	123,675	1.09	106,741	1.32	863	0.288	1.62
289	Misc Chem Prod.	62,754	0.55	75,142	0.93	1197	0.486	1.97
28	Total	800,874	7.03	899,377	11.16	-	-	-
28	Chemicals or Allied Prod.	805,000	7.07	905,468	11.24	1125	0.413	1.79
291	Products of Petro Ref'g	195,250	1.71	159,585	1.98	818	0.340	2.02
295	Paving or Roofing Mat'ls	11,154	0.10	7,763	0.10	695	0.323	2.25
299	Misc. Coal or Petro. Prod.	172,779	1.52	117,028	1.45	678	0.244	1.75
29	Total	379,182	3.33	284,376	3.53	-	-	-
29	Petroleum or Coal Prod.	379,182	3.33	284,376	3.53	750	0.296	1.92

APPENDIX III-A
TABLE III-4M-5

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	M. TON-KM (THOUS)	% OF TOTAL	AVG DIST KM	AVG REVENUE (CENTS) PER KG	PER M. TON-KM
301	Tires or Inner Tubes	15,901	0.14	19,552	0.24	1230	0.841	3.32
306	Misc. Fabricated Rubber	1,432	0.01	1,581	0.02	1104	1.228	5.40
307	Misc. Plastic Prod.	8,512	0.07	11,220	0.14	1318	1.177	4.34
30	Total	25,846	0.23	32,353	0.40	-	-	-
30	Rubber or Misc Plastic	26,307	0.23	32,740	0.41	1244	0.963	3.76
31	Leather or Leather Prod.	587	0.01	546	0.01	932	0.574	2.99
322	Glass or Glassware	7,407	0.07	11,010	0.14	1487	0.844	2.76
324	Hydraulic Cement	142,246	1.25	61,932	0.77	436	0.167	1.87
325	Struct. Clay Prod.	45,136	0.40	40,722	0.51	903	0.295	1.59
327	Concrete, Gypsum Prod.	65,433	0.57	33,213	0.41	507	0.212	2.03
329	Abrasives or Asbestos	222,208	1.95	200,810	2.49	904	0.319	1.72
32	Total	482,430	4.23	347,687	4.31	-	-	-
32	Clay, Concrete, Glass	487,535	4.28	353,994	4.39	726	0.271	1.82
331	Steel Works Prod.	329,489	2.89	194,906	2.42	592	0.294	2.42
332	Iron or Steel Castings	17,907	0.16	8,450	0.10	472	0.299	3.08
333	Non Ferrous Metal	58,570	0.51	106,466	1.32	1819	0.575	1.54
335	Non Ferrous Metal Basic	21,147	0.19	34,568	0.43	1635	0.666	1.98
339	Misc. Primary Metal Prod.	6,580	0.06	4,717	0.06	716	0.410	2.77
33	Total	433,692	3.81	349,107	4.33	-	-	-
33	Primary Metal Prod.	435,071	3.82	350,148	4.34	805	0.353	2.13
341	Metal Cans	2,733	0.02	3,143	0.04	1151	1.409	5.96
344	Fab Struct. Metal Prod.	44,806	0.39	44,379	0.55	990	0.536	2.63
349	Misc. Fab. Metal Prod.	6,330	0.06	7,538	0.09	1191	0.737	3.01
34	Total	53,870	0.47	55,060	0.68	-	-	-
34	Fabricated Metal Prod.	58,491	0.51	61,993	0.77	1061	0.637	2.92

APPENDIX III-A

TABLE III-4M-6

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	% OF TOTAL	M. TON-KM (THOUS)	% OF TOTAL	AVG DIST KM	AVG REVENUE (CENTS) PER KG	AVG REVENUE (CENTS) PER M. TON-KM
352	Farm Mach'y or Equip.	6,426	0.06	10,140	0.13	1579	1.339	4.12
353	Const'n Mach'y or Equip.	9,948	0.09	15,100	0.19	1518	1.082	3.47
358	Service Indus. Mach's.	1,918	0.02	2,625	0.03	1370	1.335	4.74
35	Total	18,292	0.16	27,865	0.35	-	-	-
35	Machinery	24,097	0.21	36,612	0.45	1519	1.191	3.81
363	Household Appliances	15,480	0.14	21,866	0.27	1413	1.462	5.03
364	Elec. Lighting or Wire Equip.	1,818	0.02	2,891	0.04	1590	1.200	3.67
365	Radio or TV Rec. Sets	1,903	0.02	3,294	0.04	1730	1.140	3.21
36	Total	19,201	0.17	28,050	0.35	-	-	-
36	Elec. Mach'y or Equip.	23,604	0.21	34,273	0.43	1452	1.347	4.51
371	Motor Vehicles	220,653	1.94	287,274	3.56	1302	1.287	4.80
374	Railroad Equip.	22,386	0.20	18,283	0.23	816	0.460	2.74
37	Total	243,038	2.13	305,558	3.79	-	-	-
37	Transportation Equip.	244,334	2.14	307,378	3.81	1259	1.212	4.68
38	Instru. or Photo. Goods	1,024	0.01	1,569	0.02	1532	0.977	3.10
394	Toys, Amuse, or Sport. Goods	1,837	0.02	2,742	0.03	1492	1.578	5.14
39	Total	1,837	0.02	2,742	0.03	-	-	-
39	Misc. Prod. of Mfrg	2,727	0.02	4,599	0.06	1687	1.539	4.44
402	Waste or Scrap	303,692	2.67	125,645	1.56	414	0.239	2.81
40	Total	303,692	2.67	125,645	1.56	-	-	-
40	Waste or Scrap Mat'ls	304,063	2.67	125,911	1.56	414	0.239	2.80

APPENDIX III-A
TABLE III-4M-7

STCC	DESCRIPTION	WEIGHT (METRIC TONS)	T OF TOTAL	M. TON - KM (THOUS)	% OF TOTAL	AVG DIST KM	AVG REVENUE (CENTS) PER KG	AVG REVENUE (CENTS) PER M. TON-KM
411	Misc. Freight Shipments	3,411	0.03	4,092	0.05	1199	1.058	4.29
41	Total	3,411	0.03	4,092	0.05	-	-	-
41	Misc. Freight Shipments	3,973	0.03	4,400	0.05	1107	0.943	4.14
421	Cont. Ship'g Ret. Empty	6,056	0.05	8,345	0.10	1378	0.720	2.54
422	Trailers, Semi's, Ret. Empty	3,650	0.03	3,873	0.05	1062	0.359	1.64
42	Total	9,706	0.09	12,219	0.15	-	-	-
42	Containers, Shipping, Ret. Empty	9,706	0.09	12,219	0.15	1259	0.585	2.25
441	Frt Fwdr Traffic	25,896	0.23	66,348	0.82	2562	1.036	1.97
44	Total	25,896	0.23	66,348	0.82	-	-	-
44	Frt Fwdr Traffic	25,896	0.23	66,348	0.82	2562	1.036	1.97
451	Shipper Assoc or Sim. Traff.	42,268	0.37	85,779	1.06	2029	0.881	2.11
45	Total	42,268	0.37	85,779	1.06	-	-	-
45	Shipper Assoc or Sim. Traff.	42,268	0.37	85,779	1.06	2029	0.881	2.11
461	Misc. Mixed Shipments	144,394	1.27	236,453	2.93	1638	0.683	2.03
46	Total	144,394	1.27	236,453	2.93	-	-	-
46	Misc. Mixed	145,081	1.27	237,683	2.95	1638	0.684	2.03

APPENDIX III-B

CENSUS OF TRANSPORTATION DATA

U. S. DOMESTIC FREIGHT
AIR PENETRATION
ALL MANUFACTURED GOODS

	ALL MODES TONS	AIR ONLY TONS	AIR PENETRATION %
ALL DISTANCES	657,969,104	674,528	0.103
LESS THAN 500 MILES	462,308,610	127,698	0.028
OVER 500 MILES	195,660,494	546,830	0.279
OVER 1000 MILES	89,320,254	334,575	0.375
OVER 1500 MILES	35,347,807	225,049	0.637
OVER 2000 MILES	7,469,009	134,533	1.801

SOURCE: 1972 CENSUS OF TRANSPORTATION PRODUCTION AREA/DESTINATION AREA DATA

Appendix III-B
Table III-1

U. S. DOMESTIC FREIGHT

AIR PENETRATION

ALL MANUFACTURED GOODS LESS 29XXX

	ALL MODES TONS	AIR ONLY TONS	AIR PENETRATION %
ALL DISTANCES	558,205,726	670,915	0.120
LESS THAN 500 MILES	417,677,376	124,515	0.030
OVER 500 MILES	140,528,350	546,400	0.389
OVER 1000 MILES	55,230,181	334,567	0.606
OVER 1500 MILES	27,796,396	225,045	0.810
OVER 2000 MILES	7,390,869	134,529	1.820

SOURCE: 1972 CENSUS OF TRANSPORTATION PRODUCTION AREA/DESTINATION AREA DATA

Appendix III-B
Table III-2

U. S. DOMESTIC FREIGHT

TONNAGE VERSUS DISTANCE

ALL MANUFACTURED GOODS

	TONS	PERCENTAGE OF TONS
ALL MODES		
ALL DISTANCES	657,969,104	100.0
LESS THAN 500 MILES	462,308,610	70.3
OVER 500 MILES	195,660,494	29.7
OVER 1000 MILES	89,320,254	13.6
OVER 1500 MILES	35,347,807	5.4
OVER 2000 MILES	7,469,009	1.1
AIR ONLY		
ALL DISTANCES	674,528	100.0
LESS THAN 500 MILES	127,698	18.9
OVER 500 MILES	546,830	81.1
OVER 1000 MILES	334,575	49.6
OVER 1500 MILES	225,049	33.4
OVER 2000 MILES	134,533	19.9

SOURCE: 1972 CENSUS OF TRANSPORTATION PRODUCTION AREA/DESTINATION AREA DATA

Appendix III-B
Table III-3-1

U. S. DOMESTIC FREIGHT

TONNAGE VERSUS DISTANCE

ALL MANUFACTURED GOODS

	TONS	PERCENTAGE OF TONS
SURFACE MODES		
ALL DISTANCES	657,294,576	100.0
LESS THAN 500 MILES	462,180,912	70.3
OVER 500 MILES	195,113,664	29.7
OVER 1000 MILES	88,985,679	13.5
OVER 1500 MILES	35,122,758	5.3
OVER 2000 MILES	7,334,476	1.1

Appendix III-B
Table III-3-2

U. S. DOMESTIC FREIGHT

TONNAGE VERSUS DISTANCE

ALL MANUFACTURED GOODS LESS 29XXX

ALL MODES	TONS	PERCENTAGE OF TONS
ALL DISTANCES	558,205,726	100.0
LESS THAN 500 MILES	417,677,376	74.8
OVER 500 MILES	140,528,350	25.2
OVER 1000 MILES	55,230,181	9.9
OVER 1500 MILES	27,796,396	5.0
OVER 2000 MILES	7,390,869	1.3
AIR ONLY		
ALL DISTANCES	670,915	100.0
LESS THAN 500 MILES	124,515	18.6
OVER 500 MILES	546,400	81.4
OVER 1000 MILES	334,566	49.9
OVER 1500 MILES	225,045	33.5
OVER 2000 MILES	134,529	20.1

SOURCE: 1972 CENSUS OF TRANSPORTATION
PRODUCTION AREA/DESTINATION AREA DATA

Appendix III-B
Table III-4-1

U. S. DOMESTIC FREIGHT

TONNAGE VERSUS DISTANCE

ALL MANUFACTURED GOODS LESS 29XXX

SURFACE MODES	TONS	PERCENTAGE OF TONS
ALL DISTANCES	557,534,811	100.0
LESS THAN 500 MILES	417,552,861	74.9
OVER 500 MILES	139,981,950	25.1
OVER 1000 MILES	54,895,612	9.8
OVER 1500 MILES	27,571,351	4.9
OVER 2000 MILES	7,256,340	1.3

SOURCE: 1972 CENSUS OF TRANSPORTATION

Appendix III-B
Table III-4-2

U. S. DOMESTIC FREIGHT

TONNAGE VERSUS DISTANCE

COMMODITIES 29XXX

	TONS	PERCENTAGE OF TONS
ALL MODES		
ALL DISTANCES	99,763,378	100.0
LESS THAN 500 MILES	44,631,234	44.7
OVER 500 MILES	55,132,144	55.3
OVER 1000 MILES	34,090,074	34.2
OVER 1500 MILES	7,551,411	7.6
OVER 2000 MILES	78,141	0.08
AIR ONLY		
ALL DISTANCES	3613	100.0
LESS THAN 500 MILES	3183	88.1
OVER 500 MILES	430	11.9
OVER 1000 MILES	9	0.2
OVER 1500 MILES	3.7	0.1
OVER 2000 MILES	3.5	0.1

SOURCE: 1972 CENSUS OF TRANSPORTATION

Appendix III-B
Table III-5

Appendix III-B
Table III-6

AIR PENETRATION - BY TON-MILES

DISTANCES GREATER THAN S.M.	AIR OF TOTAL TONS %	AIR OF RAIL TRUCK & AIR %	AIR OF TRUCK & AIR %
0	0.375	0.492	1.087
100	0.388	1.512	1.177
200	0.418	0.559	1.389
400	0.499	0.695	2.026
500	0.532	0.762	2.300
750	0.621	0.964	3.118
1000	0.744	1.115	3.732
1500	0.950	1.430	5.044
2000	1.916	2.108	6.421

AIR PENETRATION - BY TONS

0	0.120	0.139	0.211
100	0.164	0.197	0.343
200	0.218	0.267	0.547
400	0.342	0.450	1.221
500	0.389	0.538	1.541
750	0.494	0.793	2.494
1000	0.606	0.951	3.146
1500	0.810	1.318	4.768
2000	1.820	1.987	6.281

APPENDIX III-C

METRIC UNIT TABLES

TABLE III-1M-1. DEPARTMENT OF TRANSPORTATION FORECAST

Tonnage

	1975		1980		1990		Annual Growth Rate - %
	% Share	Metric Tons Millions	% Share	Metric Tons Millions	% Share	Metric Tons Millions	1980-1990
Rail	30	1342.7	30	1737.1	32	2323.4	2.95
Motor Carrier	15	671.3	15	868.6	16	1161.7	2.95
Private Truck	17	760.8	17.5	1013.3	18	1306.9	2.58
Sub Total	62	2774.8	62.5	3619.1	66	4792.2	2.85
Water	20	895.1	20	1158.1	19	1379.5	1.77
Pipeline	18	798.4	17	984.3	15	1089.1	1.02
Air	.1	4.4	.1	5.8	.1	7.2	2.26
Grand Total	100	4475.7	100	5790.5	100	7260.9	2.29

Ton Kilometres

	1975		1980		1990		Annual Growth Rate - %
	% Share	Metric Ton-Kilometres Billions	% Share	Metric Ton-Kilometres Billions	% Share	Metric Ton-Kilometres Billions	1980-1990
Rail	33.5	1111	40.2	1682	42.5	2561	4.29
Motor Carrier	8.6	286	7.2	304	9.5	575	6.60
Private Truck	10.8	358	8.6	362	6.6	399	0.97
Sub Total	52.9	1755	56.0	2348	58.6	3535	4.18
Water	24.5	813	22.7	949	20.1	1210	2.46
Pipeline	22.4	744	21.1	885	21.0	1267	3.66
Air	0.18	6	0.17	7	0.22	13	6.05
Grand Total	99.98	3319	99.97	4189	99.92	6025	3.70

Source: U. S. DOT National
Transportation Trends &
Choices To The Year 2000,
Page 69, for Tonnage &
Mr. Costello, DOT for Ton-Miles

TABLE III-1M-2

Average Distance - Kilometres

	1975	1980	1990
Rail	827.5	968.1	1102.0
Motor Carrier	426.3	349.5	495.1
Private Truck	470.0	357.2	304.9
Sub Total	632.4	648.7	737.5
Water	908.4	819.4	877.2
Pipeline	932.6	898.8	1163.5
Air	1313.7	1237.9	1810.5
Grand Total	741.4	723.4	829.7

TABLE III-3M. RAIL AND TRUCK FORECAST (MILLION METRIC TONS)

Year	Rail Class I & II	Truck ICC-Regulated	Truck Non-ICC Regulated	Total Truck	Total Rail & Truck	GNP Mfg. 1972 $'s Billions	Kg/$ GNP (Mfg)
1940	970	55	191	247	1241		
1941	1176	70	283	353	1529		
1942	1359	75	185	260	1619		
1943	1412	87	178	265	1677		
1944	1420	95	198	293	1713		
1945	1354	98	259	357	1712		
1946	1299	102	321	423	1722		
1947	1463	122	382	504	1968	114.9	17.1
1948	1433	151	368	519	1952	121.5	16.1
1949	1165	160	412	572	1736	115.0	15.1
1950	1289	193	527	720	2009	131.3	15.3
1951	1403	215	575	790	2194	146.0	15.0
1952	1313	220	608	828	2141	150.7	14.2
1953	1314	245	669	914	2218	161.2	13.7
1954	1160	246	691	937	2097	149.6	14.0
1955	1324	285	679	964	2288	165.8	13.8
1956	1380	299	810	1109	2489	166.9	14.9
1957	1315	299	710	1010	2324	167.8	13.8
1958	1131	298	719	1018	2149	153.3	14.0
1959	1173	340	709	1049	2222	170.7	13.0
1960	1180	351	720	1071	2252	172.0	13.1
1961	1137	364	836	1200	2337	171.2	13.7
1962	1174	399	890	1289	2463	186.2	13.2
1963	1222	415	952	1367	2589	201.0	12.9
1964	1288	451	1064	1515	2803	215.7	13.0
1965	1342	505	983	1489	2830	235.1	12.0
1966	1400	550	1032	1582	2982	254.0	11.7
1967	1359	544	1129	1674	3033	254.1	11.9
1968	1374	582	1060	1643	3017	268.4	11.2
1969	1413	580	1024	1604	3017	276.2	10.9
1970	1426	600	1059	1658	3084	260.6	11.8
1971	1335	641	1048	1689	3025	264.1	11.4
1972	1389	699	1055	1754	3143	288.8	10.9
1973	1466	753	1087	1840	3300	313.0	10.6
1974	1469	726	1048	1774	3242	296.8	10.9
1975	1334	624	901	1525	2859	270.0	10.6
1976	1340	711	1026	1737	3077		
1980					3529	360.2	9.8
1985					3797	416.5	9.1
1990					4157	490.0	8.5
1995					4525	573.3	7.9
2000					4902	671.3	7.3

TABLE III-4M. SMALL SHIPMENT HISTORY AND FORECAST

Year	Motor LTL Class I & II	Rail LCL Class I & II	Rail & Truck	GNP Manufacturing 1972 $'s Billions	Kg/$ GNP (Mfg).
	Net Metric Tons - In Thousands				
1950	48,448	20,107	68,555	131.3	.52
1951	44,399	19,307	63,705	146.0	.44
1952	45,010	17,228	62,238	150.7	.41
1953	46,993	15,251	62,244	161.2	.39
1954	45,612	12,936	58,549	149.6	.39
1955	49,108	12,741	61,849	165.8	.37
1956	51,676	11,906	63,582	166.9	.38
1957	52,557	10,181	62,738	167.8	.37
1958	51,049	7,957	59,006	153.3	.39
1959	56,900	7,013	63,912	170.7	.38
1960	56,376	5,849	62,225	172.0	.36
1961	57,631	4,857	62,488	171.2	.36
1962	62,179	4,058	66,237	186.2	.35
1963	64,223	3,035	67,258	201.0	.34
1964	66,268	2,219	68,487	215.7	.32
1965	69,759	1,928	71,687	235.1	.30
1966	74,433	1,497	75,930	254.0	.30
1967	72,747	1,372	74,119	254.1	.29
1968	75,499	1,177	76,675	268.4	.29
1969	76,662	1,160	77,822	276.2	.28
1970	70,850	1,068	71,918	260.6	.28
1971	71,214	998	72,212	264.1	.27
1972	75,115	879	75,994	288.8	.26
1973	76,012	677	76,690	313.0	.24
1974	78,018	600	78,618	296.8	.26
1980			83,326	360.2	.23
1985			86,904	416.5	.21
1990			91,127	490.0	.19
1995			92,217	573.3	.17
2000			100,484	671.3	.15

TABLE III-5M. SHIPMENTS BY MANUFACTURING ESTABLISHMENTS - METRIC TONS

Year	1963	1967	1972	1980	1990	2000
All Commodities - Bulk and Manufactured - Rail and Truck Only Total Freight Movements - Metric Tons (Millions)						
Rail	1222	1359	1389	1737	2323	2903
Motor Carrier	415	544	699	869	1162	1451
Private Truck	952	1130	1055	1013	1307	1633
Total Truck	1367	1674	1754	1882	2469	3084
Rail & Truck	2589	3033	3143	3619	4792	5987
Total All-Modes Manufactured Goods(1) Metric Tons (Millions)						
	800.614	877.209	1015.710			
Percent Distribution - Rail and Truck Only						
Rail	43.9	44.6	38.7			
Motor Carrier	32.9	33.5	35.8			
Private Truck	19.9	17.6	21.3			
Manufactured Goods(1) by Rail and Truck - Metric Tons (Millions)						
Rail	351.470	391.235	393.080	478	618	749
Motor Carrier	263.402	293.865	363.624	425	526	610
Private Truck	159.323	154.388	216.346	202	252	304
Total Truck	422.725	448.253	579.970	627	778	914
Rail & Truck	774.195	839.488	973.050	1105	1396	1663
Manufactured Goods Movements - Percent Share of Total Freight Movements						
Rail	28.8	28.8	28.3	27.5	26.6	25.8
Motor Carrier	63.4	54.0	52.0	49.0	45.3	42.0
Private Truck	16.7	13.7	20.5	20.0	19.3	18.6
Total Truck	30.9	26.8	33.1	33.3	31.5	29.6
Rail & Truck	29.9	27.7	31.0	30.6	29.1	27.8

(1) Manufactured goods for 23 Shipper Groups excluding Petroleum and Coal Products.

Sources:
Historical Data - TAA Facts & Trends
Forecast Data - Based on DOT Trends & Choices

TABLE III-6M. 1972 CENSUS RESULTS

Rank	Top Commodities by Tons	Total Metric Tons (Millions)	Rail Metric Tons (Millions)	Percent Rail of Total
	All 23 Shipper Groups(1)	1,015,710	393,080	38.7
1	Stone, Clay, & Glass Products	161,590	35,388	21.9
2	Canned Frozen & Other Food Products	139,720	70,838	50.7
3	Primary Iron & Steel Products	126,517	55,287	43.7
4	Chemicals, Plastics, Etc.	101,471	49,315	48.6
5	Paper & Allied Products	81,111	42,015	51.8
6	Lumber & Wood Products Except Furniture	72,567	33,308	45.9
7	Drugs, Paints & Other Chem. Products	53,435	20,198	37.8
8	Candy, Beverages & Tobacco Products	52,613	8,102	15.4
9	Meat & Dairy Products	38,661	7,268	18.8
	Top 9 Shipper Groups	827,685	321,719	38.9
	Top 9 as Percent of Total	81.5	81.8	
10	Motor Vehicles & Equipment	36,278	21,513	59.3
	Top 10 as Percent of Total	85.1	87.3	

(1) The total for the 23 Shipper Groups excludes Petroleum and Coal Products

TABLE III-7M. MARKET UNIVERSE FOR AACS AND CASE STUDY CORRELATION
MANUFACTURED GOODS ONLY

Year	1963	1967	1972	1980	1990	2000
		Million Metric Tons				
Rail - Total	351.470	391.235	393.080	478	618	749
Rail over 1287 km (1)	76.621	85.289	85.692	104	134	163
Rail - Specific Commodities(2)	15.324	17.058	17.139	21	27	33
Truck - Total	422.725	448.254	579.970	628	778	914
Truck over 1287 km(3)	21.136	22.413	28.998	32	39	45
Truck - Specific Commodities(4)	21.136	22.413	28.998	32	39	45
Rail & Truck						
Total	774.195	839.489	973.050	1106	1396	1663
Over 1287 km	97.757	107.702	114.690	136	173	208
Specific Commodities	36.460	39.471	46.137	53	66	78
Case Study Results for 45% Rate Reductions						
Percent of Universe			19.0	19.0	19.0	19.0
Air Tonnage with AACS			8.773	10	13	15
ATA Belly Cargo Forecast(5)				3	5	8
Remaining demand for AACS				7	7	6

(1) 21.8 percent of rail tons move over 1287 km (800 m)
(2) 20 percent of rail tons move at yields of 2¢/mtkm or more
(3) 5 percent of truck tons move over 1287 km (800 m)
(4) All manufactured goods by truck considered eligible for AACS
(5) Specific Commodities (Rail & Truck) times Percent of Universe/100
(6) Air Transport Association of America Cargo Forecast 1975 - 2000, January 1978.

TABLE III - 11M. MARAD SEABORNE DATA ANALYSIS

CONTAINERIZABLE CARGO - IMPORTS & EXPORTS

PERCENT CONTAINERIZATION	TOTAL METRIC TONS OF COMMODITIES 1975	1990	2000
60 - 100	4,869,062	14,433,408	26,408,107
40 - 60	7,297,929	15,870,124	25,643,797
20 - 40	13,798,079	24,488,224	35,379,649
5 - 20	31,954,074	56,296,886	83,746,566
0 - 5	87,901,049	190,880,931	312,871,492
TOTAL	145,820,193	301,969,573	484,049,611
BULK COMMODITIES	486,506,218	790,783,496	959,635,775
TOTAL TRADE	632,326,411	1,092,753,069	1,443,685,386
% CONTAINERIZABLE COMMODITIES	23.1	27.6	33.5

TABLE III - 12M. MARAD SEABORNE DATA ANALYSIS

CONTAINERIZABLE CARGO - IMPORTS

PERCENT CONTAINERIZATION	TOTAL METRIC TONS OF COMMODITIES 1975	1990	2000
60 - 100	4,145,666	11,545,673	20,120,984
40 - 60	2,834,915	7,073,687	12,102,186
20 - 40	3,342,699	5,392,767	7,498,799
5 - 20	10,272,507	19,403,842	29,678,013
0 - 5	30,502,633	61,553,095	95,804,696
TOTAL	51,098,420	104,969,064	165,204,678
BULK COMMODITIES	337,039,433	571,355,893	665,710,017
TOTAL IMPORTS	388,137,853	676,324,957	830,914,695
% OF CONTAINERIZABLE COMMODITIES	13.2	15.5	19.9

TABLE III - 13M. MARAD SEABORNE DATA ANALYSIS

CONTAINERIZABLE CARGO - EXPORTS

PERCENT CONTAINERIZATION	TOTAL METRIC TONS OF COMMODITIES 1975	1990	2000
60 - 100	723,396	2,887,735	6,287,123
40 - 60	4,463,014	8,796,437	13,541,611
20 - 40	10,455,380	19,095,457	27,880,850
5 - 20	21,681,567	36,893,044	54,068,553
0 - 5	57,398,416	129,327,836	217,066,796
TOTAL	94,721,773	197,000,509	318,844,933
BULK COMMODITIES	149,466,785	219,427,603	293,925,758
TOTAL EXPORTS	244,188,558	416,428,112	612,770,691
% OF CONTAINERIZABLE COMMODITIES	38.8	47.3	52.0

TABLE III - 14M. MARAD SEABORNE DATA ANALYSIS

CONTAINERIZED CARGO - IMPORTS & EXPORTS

PERCENT CONTAINERIZATION	TOTAL METRIC TONS CONTAINERIZED		
	1975	1990	2000
60 - 100	3,895,250	11,546,725	21,126,484
40 - 60	3,648,985	7,935,080	12,821,921
20 - 40	4,139,417	7,346,466	10,613,888
5 - 20	3,938,751	6,930,929	10,316,353
0 - 5	1,804,153	3,804,490	6,133,727
TOTAL	17,426,556	37,563,690	61,012,373
BULK COMMODITIES	614,899,855	1,055,189,395	1,382,673,013
TOTAL TRADE	632,326,411	1,092,753,085	1,443,685,386
% CONTAINERIZED COMMODITIES	2.8	3.4	4.2

TABLE III - 15M. MARAD SEABORNE DATA ANALYSIS

CONTAINERIZED CARGO - IMPORTS

PERCENT CONTAINERIZATION	TOTAL METRIC TONS CONTAINERIZED 1975	1990	2000
60 - 100	3,316,531	9,236,538	16,096,787
40 - 60	1,417,466	3,536,848	6,051,100
20 - 40	1,002,806	1,617,830	2,249,636
5 - 20	1,218,949	2,294,547	3,515,216
0 - 5	723,582	1,387,479	2,158,794
TOTAL	7,679,334	18,073,242	30,071,533
BULK COMMODITIES	380,458,519	658,251,731	800,843,162
TOTAL IMPORTS	388,137,853	676,324,957	830,914,695
% OF CONTAINERIZED COMMODITIES	2.0	2.7	3.6

TABLE III - 16M. MARAD SEABORNE DATA ANALYSIS

CONTAINERIZED CARGO - EXPORTS

PERCENT CONTAINERIZATION	TOTAL METRIC TONS CONTAINERIZED		
	1975	1990	2000
60 - 100	578,719	2,310,187	5,029,697
40 - 60	2,231,519	4,398,232	6,770,821
20 - 40	3,136,611	5,728,636	8,364,252
5 - 20	2,719,802	4,636,382	6,801,137
0 - 5	1,080,571	2,417,011	3,974,933
TOTAL	9,747,222	19,490,448	30,940,840
BULK COMMODITIES	234,441,336	396,937,664	581,829,851
TOTAL EXPORTS	244,188,558	416,428,112	612,770,691
% CONTAINERIZED COMMODITIES	4.0	4.7	5.1

TABLE III - 17M. MARAD SEABORNE DATA ANALYSIS

AIR DISTANCES - KILOMETERS

TO/FROM	NEW YORK	CHICAGO	LOS ANGELES	AVERAGE(1)
1. CANADA	-	-	-	1,609
2. OECD EUROPE	6,437	7,081	9,173	7,178
3. OTHER FREE EUROPE	-	-	-	7,242
4. JAPAN	10,944	10,139	8,690	10,252
5. AUSTRALIA	16,576	15,289	12,231	15,321
6. NEW ZEALAND	15,128	13,518	10,622	13,744
7. MIDDLE EAST	10,622	11,426	13,358	11,410
8. AFRICA	9,656	11,265	12,875	10,783
9. L/D ASIA	16,254	14,967	13,518	15,321
10. L/D AMERICA	7,725	8,690	10,461	8,562
11. COMMUNIST EUROPE	7,403	8,047	10,139	8,143
12. COMMUNIST ASIA	13,358	12,553	11,104	12,666
13. ALL OTHER COUNTRIES	-	-	-	9,978

(1) Weighted average based on traffic distribution of 50% New York, 30% Chicago, and 20% Los Angeles.

TABLE III - 18M. MARAD SEABORNE DATA ANSLYSIS

CONTAINERIZED CARGO - IMPORTS + EXPORTS - METRIC TONS

REGION	DISTANCE KM	1975 METRIC TONS	1975 % OF TOTAL	1990 METRIC TONS	1990 % OF TOTAL	2000 METRIC TONS	2000 % OF TOTAL
1. CANADA	1,609	461,552	2.65	1,022,638	2.72	1,554,693	2.55
2. OECD EUROPE	7,179	6,679,855	38.33	14,848,230	39.53	24,455,677	40.08
3. OTHER FREE EUROPE	7,242	86,743	0.50	204,430	0.54	337,096	0.55
4. JAPAN	10,252	2,998,078	17.21	7,019,753	18.69	11,442,151	18.75
5. AUSTRALIA	15,321	490,842	2.82	1,271,201	3.38	2,150,118	3.52
6. NEW ZEALAND	13,744	152,091	0.87	360,373	0.96	555,354	0.91
7. MIDDLE EAST	11,410	572,396	3.28	1,086,546	2.89	1,761,018	2.89
8. AFRICA	10,783	594,236	3.41	885,029	2.36	1,307,382	2.14
9. L/D ASIA	15,321	2,353,023	13.50	5,172,243	13.77	8,557,467	14.03
10. L/D AMERICA	8,562	2,574,545	14.77	4,743,711	12.63	7,349,533	12.05
11. COMMUNIST EUROPE	8,143	323,245	1.85	632,137	1.68	1,008,073	1.65
12. COMMUNIST ASIA	12,666	119,659	0.69	284,813	0.76	492,958	0.81
13. ALL OTHER COUNTRIES	9,978	20,443	0.12	32,726	0.09	40,998	0.07
TOTAL		17,426,708		37,563,830		61,012,518	

TABLE III - 19M. MARAD SEABORNE DATA ANALYSIS

CONTAINERIZED CARGO - IMPORTS - METRIC TONS

REGION	DISTANCE KM	1975 METRIC TONS	1975 % OF TOTAL	1990 METRIC TONS	1990 % OF TOTAL	2000 METRIC TONS	2000 % OF TOTAL
1. CANADA	1,609	242,101	3.15	398,092	2.20	556,403	1.85
2. OECD EUROPE	7,178	3,031,622	39.48	7,543,000	41.74	12,816,611	42.62
3. OTHER FREE EUROPE	7,242	50,695	0.66	95,591	0.53	149,220	0.50
4. JAPAN	10,252	1,587,429	20.67	4,297,854	23.78	7,369,047	24.51
5. AUSTRALIA	15,321	273,185	3.56	688,022	3.81	1,157,852	3.85
6. NEW ZEALAND	13,744	102,064	1.33	210,008	1.16	293,109	0.97
7. MIDDLE EAST	11,410	48,634	0.63	100,550	0.56	160,229	0.53
8. AFRICA	10,783	124,179	1.62	138,824	0.77	161,779	0.54
9. L/D ASIA	15,321	1,209,823	15.75	2,891,339	16.00	4,921,055	16.36
10. L/D AMERICA	8,562	840,720	10.95	1,434,752	7.94	2,039,299	6.78
11. COMMUNIST EUROPE	8,143	136,039	1.77	208,734	1.15	320,022	1.06
12. COMMUNIST ASIA	12,666	29,025	0.38	56,661	0.31	115,500	0.38
13. ALL OTHER COUNTRIES	9,978	3,866	0.05	9,855	0.05	11,449	0.04
TOTAL		7,679,382		18,073,282		30,071,575	

TABLE III - 20M. MARAD SEABORNE DATA ANALYSIS

CONTAINERIZED CARGO - EXPORTS - METRIC TONS

		1975		1990		2000	
REGION	DISTANCE KM	METRIC TONS	% OF TOTAL	METRIC TONS	% OF TOTAL	METRIC TONS	% OF TONS
1. CANADA	1,609	219,451	2.25	624,546	3.20	998,290	3.23
2. OECD EUROPE	7,178	3,648,233	37.43	7,305,230	37.48	11,639,066	31.62
3. OTHER FREE EUROPE	7,242	36,048	0.37	108,839	0.56	187,876	0.61
4. JAPAN	10,252	1,410,649	14.47	2,721,899	13.97	4,073,104	0.13
5. AUSTRALIA	15,321	217,657	2.23	583,179	2.99	992,266	3.21
6. NEW ZEALAND	13,744	50,027	0.51	150,365	0.77	262,245	0.85
7. MIDDLE EAST	11,410	523,762	5.37	985,996	5.06	1,600,789	5.17
8. AFRICA	10,783	470,057	4.82	746,205	3.83	1,145,603	3.70
9. L/D ASIA	15,321	1,143,200	11.73	2,280,904	11.70	3,636,412	11.75
10. L/D AMERICA	8,562	1,735,825	17.79	3,308,959	16.98	5,310,234	17.16
11. COMMUNIST EUROPE	8,143	187,206	1.92	423,403	2.17	688,051	2.22
12. COMMUNIST ASIA	12,666	90,634	0.93	228,152	1.17	377,458	1.22
13. ALL OTHER COUNTRIES	9,978	16,577	0.17	22,871	0.12	29,549	0.10
TOTAL		9,747,326		19,490,548		30,940,943	

TABLE III - 21M. MARAD SEABORNE DATA ANALYSIS

CONTAINERIZED CARGO - IMPORTS & EXPORTS - METRIC TON-KILOMETERS

REGION	DISTANCE KM	1975		1990		2000	
		MT-KM (MILLIONS)	% OF TOTAL	MT-KM (MILLIONS)	% OF TOTAL	MT-KM (MILLIONS)	% OF TOTAL
1. CANADA	1,609	742.811	0.45	1,645.783	0.46	2,502.038	0.43
2. OECD EUROPE	7,178	47,945.915	29.05	106,575.792	29.86	175,534.854	30.19
3. OTHER FREE EUROPE	7,242	628.211	0.38	1,480.457	0.41	2,441.176	0.42
4. JAPAN	10,252	30,734.866	18.62	71,963.080	20.16	117,299.328	20.17
5. AUSTRALIA	15,321	7,520.033	4.56	19,476.065	5.46	32,941.840	5.67
6. NEW ZEALAND	13,744	2,090.288	1.27	4,952.953	1.39	7,632.673	1.31
7. MIDDLE EAST	11,410	6,530.979	3.96	12,397.751	3.47	20,093.726	3.46
8. AFRICA	10,783	6,407.413	3.88	9,542.689	2.67	14,097.199	2.42
9. L/D ASIA	15,321	36,050.699	21.84	79,243.813	22.20	131,108.480	22.55
10. L/D AMERICA	8,562	22,042.413	13.36	40,614.338	11.38	62,924.606	10.82
11. COMMUNIST EUROPE	8,143	2,632.329	1.59	5,147.700	1.44	8,209.005	1.41
12. COMMUNIST ASIA	12,666	1,515.552	0.92	3,607.281	1.01	6,243.691	1.07
13. ALL OTHER COUNTRIES	9,978	203.884	0.12	326.517	0.09	409.151	0.07
TOTAL		165,045.39		356,974.22		581,437.77	

TABLE III - 22M. MARAD SEABORNE DATA ANALYSIS
CONTAINERIZED CARGO - IMPORTS - METRIC TON-KILOMETERS

		1975		1990		2000	
REGION	DISTANCE KM	MT-KM (MILLIONS)	% OF TOTAL	MT-KM (MILLIONS)	% OF TOTAL	MT-KM (MILLIONS)	% OF TOTAL
1. CANADA	1,609	389.629	0.53	640.678	0.37	895.454	0.31
2. OECD EUROPE	7,178	21,760.058	29.60	54,141.189	30.99	91,993.457	31.52
3. OTHER FREE EUROPE	7,242	367.138	0.50	692.275	0.40	1,080.607	0.37
4. JAPAN	10,252	16,273.544	22.13	44,059.597	25.22	75,543.915	25.88
5. AUSTRALIA	15,321	4,185.373	5.69	10,541.203	6.03	17,739.352	6.08
6. NEW ZEALAND	13,744	1,402.731	1.91	2,886.281	1.65	4,028.451	1.38
7. MIDDLE EAST	11,410	554.825	0.75	1,147.275	0.66	1,828.199	0.63
8. AFRICA	10,783	1,338.984	1.82	1,496.794	0.86	1,744.547	0.60
9. L/D ASIA	15,321	18,535.677	25.21	44,298.093	25.36	75,395.225	25.83
10. L/D AMERICA	8,562	7,197.976	9.79	12,284.013	7.03	17,459.900	5.98
11. COMMUNIST EUROPE	8,143	1,107.875	1.51	1,699.825	0.97	2,606.001	0.89
12. COMMUNIST ASIA	12,666	367.576	0.50	717.630	0.41	1,462.939	0.50
13. ALL OTHER COUNTRIES	9,978	38.589	0.05	98.275	0.06	114.243	0.04
TOTAL		73,519.975		174,703.128		291,892.290	

TABLE III - 23M. MARAD SEABORNE DATA ANALYSIS
CONTAINERIZED CARGO - EXPORTS - METRIC TON-KILOMETERS

REGION	DISTANCE KM	1975 MT-KM (MILLIONS)	1975 % OF TOTAL	1990 MT-KM (MILLIONS)	1990 % OF TOTAL	2000 MT-KM (MILLIONS)	2000 % OF TOTAL
1. CANADA	1,609	353.182	0.39	1,005.105	0.55	1,606.584	0.55
2. OECD EUROPE	7,178	26,185.856	28.61	52,434.603	28.77	83,541.404	28.85
3. OTHER FREE EUROPE	7,242	261.074	0.29	788.182	0.43	1,360.569	0.47
4. JAPAN	10,252	14,461.322	15.80	27,903.483	15.31	41,755.413	14.42
5. AUSTRALIA	15,321	3,334.660	3.64	8,934.861	4.90	15,202.489	5.25
6. NEW ZEALAND	13,744	687.556	0.75	2,066.673	1.13	3,604.222	1.24
7. MIDDLE EAST	11,410	5,976.154	6.53	11,250.475	6.17	18,265.527	6.31
8. AFRICA	10,783	5,068.428	5.54	8,045.894	4.41	12,352.652	4.27
9. L/D ASIA	15,321	17,515.022	19.14	34,945.720	19.17	55,713.261	19.24
10. L/D AMERICA	8,562	14,844.437	16.22	28,330.325	15.54	45,464.706	15.70
11. COMMUNIST EUROPE	8,143	1,524.453	1.67	3,447.875	1.89	5,603.004	1.94
12. COMMUNIST ASIA	12,666	1,147.976	1.25	2,889.650	1.59	4,780.752	1.65
13. ALL OTHER COUNTRIES	9,978	165.295	0.18	228.242	0.13	294.909	0.10
TOTAL		91,525.415		182,271.080		289,545.490	

TABLE III - 24M. MARAD SEABORNE DATA ANALYSIS

TOTAL CARGO - IMPORTS - BY REGIONS

	1975		1990		2000	
REGION	TOTAL METRIC TONS (THOUS)	PERCENT CONTAIN-ERIZED	TOTAL METRIC TONS (THOUS)	PERCENT CONTAIN-ERIZED	TOTAL METRIC TONS (THOUS)	PERCENT CONTAIN-ERIZED
1. CANADA	32,434	0.75	49,373	0.81	58,507	0.95
2. OECD EUROPE	21,742	13.94	58,269	12.95	93,668	13.68
3. OTHER FREE EUROPE	258	19.68	340	28.10	489	30.52
4. JAPAN	9,540	16.64	17,914	23.99	26,789	27.51
5. AUSTRALIA	5,077	5.38	10,013	6.87	19,638	5.90
6. NEW ZEALAND	209	48.92	425	49.46	612	47.87
7. MIDDLE EAST	60,287	0.08	115,896	0.09	131,782	0.12
8. AFRICA	79,601	0.16	136,097	0.10	153,420	0.11
9. L/D ASIA	28,431	4.26	48,192	6.00	58,167	8.46
10. L/D AMERICA	146,792	0.57	234,892	0.61	280,314	0.73
11. COMMUNIST EUROPE	3,583	3.80	4,451	4.69	6,808	4.70
12. COMMUNIST ASIA	94	30.76	161	35.29	305	37.89
13. ALL OTHER COUNTRIES	86	4.49	293	3.36	409	2.80
	388,134	1.98	676,316	2.67	830,908	3.62

TABLE III - 25M. MARAD SEABORNE DATA ANALYSIS

TOTAL CARGO - EXPORTS - BY REGIONS

	1975		1990		2000	
REGION	TOTAL METRIC TONS (THOUS)	PERCENT CONTAIN-ERIZED	TOTAL METRIC TONS (THOUS)	PERCENT CONTAIN-ERIZED	TOTAL METRIC TONS (THOUS)	PERCENT CONTAIN-ERIZED
1. CANADA	30,191	0.73	43,112	1.45	56,690	1.76
2. OECD EUROPE	74,896	4.87	116,527	6.27	165,526	7.03
3. OTHER FREE EUROPE	342	10.54	1,132	9.61	1,705	11.02
4. JAPAN	62,233	2.27	117,610	2.31	181,244	2.25
5. AUSTRALIA	1,465	14.86	3,418	17.06	5,549	17.88
6. NEW ZEALAND	401	12.48	1,213	12.40	2,101	12.48
7. MIDDLE EAST	6,974	7.51	11,007	8.96	16,695	9.59
8. AFRICA	7,372	6.38	10,326	7.23	14,785	7.75
9. L/D ASIA	21,401	5.34	31,560	7.23	44,747	8.13
10. L/D AMERICA	25,985	6.67	45,190	7.32	69,464	7.64
11. COMMUNIST EUROPE	12,253	1.53	28,228	1.50	43,612	1.57
12. COMMUNIST ASIA	565	16.04	6,877	3.32	10,293	3.67
13. ALL OTHER COUNTRIES	107	15.48	213	10.73	274	10.79
	244,185	3.99	416,413	4.68	612,764	5.05

TABLE III - 26M. COMPARISON OF AIRBORNE AND CONTAINERIZED SEABORNE TRADE - 1975 DATA

	IMPORTS				EXPORTS			
	AIRBORNE		SEABORNE		AIRBORNE		SEABORNE	
REGION	METRIC TONS	% OF TOTAL	METRIC TONS	% OF TOTAL	METRIC TONS	% OF TOTAL	METRIC TONS	% OF TOTAL
1. CANADA	15,830	3.28	242,101	3.15	39,916	6.26	219,451	2.25
2. OECD EUROPE	183,796	38.13	3,031,622	39.48	262,539	41.18	3,648,233	37.43
3. OTHER FREE EUROPE	1,860	0.39	50,695	0.66	1,950	0.31	36,048	0.37
4. JAPAN	51,120	10.60	1,587,429	20.67	36,197	5.68	1,410,649	14.47
5. AUSTRALIA	3,039	0.63	273,185	4.89	15,604	2.45	217,657	2.74
6. NEW ZEALAND			102,064				50,027	
7. MIDDLE EAST	3,357	0.70	48,634	0.63	40,188	6.30	523,762	5.37
8. AFRICA	2,631	0.55	124,179	1.62	20,140	3.16	470,057	4.82
9. L/D ASIA	115,984	24.06	1,209,823	15.75	34,927	5.48	1,143,200	11.73
10. L/D AMERICA	101,695	21.10	840,720	10.95	181,754	28.51	1,733,825	17.79
11. COMMUNIST EUROPE	1,724	0.36	136,039	1.77	4,128	0.65	187,206	1.92
12. COMMUNIST ASIA	454	0.09	29,025	0.38	136	0.02	90,634	0.93
13. ALL OTHER COUNTRIES	590	0.12	3,866	0.05		-	16,577	0.17
	482,080	100	7,679,382	100	637,479	100	9,747,326	100

TABLE III - 27M. TOP U. S. TRADE PARTNER REGIONS IN 1975 - IMPORTS

RANKED BY SEABORNE TRADE

RANK	REGION	CONTAINERIZED SEABORNE TRADE METRIC TONS	CONTAINERIZED SEABORNE TRADE % SHARE	CONTAINERIZED SEABORNE TRADE CUM %	AIRBORNE TRADE METRIC TONS	AIRBORNE TRADE % SHARE	AIRBORNE TRADE CUM %	AIR PENETRATION PERCENT
1	OECD EUROPE	3,031,631	39.48	39.48	183,795	38.13	38.13	5.72
2	JAPAN	1,587,427	20.67	60.15	51,120	10.60	48.73	3.12
3	L/D ASIA	1,209,825	15.75	75.90	115,984	24.06	72.79	8.75
4	L/D AMERICA	840,717	10.95	86.85	101,695	21.10	93.89	10.79
5	AUSTRALIA & NEW ZEALAND	375,242	4.89	91.74	3,039	0.63	94.52	0.80
6	CANADA	242,104	3.15	94.89	15,830	3.28	97.80	6.14
	TOTAL TOP 6	7,286,946	94.89		471,463	97.80		6.08
	ALL REGIONS	7,679,384	100.00		482,078	100.00		5.91

TABLE III - 28M. TOP U. S. TRADE PARTNER REGIONS - EXPORTS

RANKED BY SEABORNE TRADE

		CONTAINERIZED SEABORNE TRADE			AIRBORNE TRADE			
RANK	REGION	METRIC TONS	% SHARE	CUM %	METRIC TONS	% SHARE	CUM %	AIR PENETRATION PERCENT
1	OECD EUROPE	3,648,237	37.43	37.43	262,539	41.18	41.18	6.71
2	L/D AMERICA	1,733,817	17.79	55.22	181,754	28.51	69.69	9.49
3	JAPAN	1,410,651	14.47	69.69	36,197	5.68	75.37	2.50
4	L/D ASIA	1,143,207	11.73	81.42	34,927	5.48	80.85	2.96
5	MIDDLE EAST	523,753	5.37	86.79	40,188	6.30	87.15	7.13
6	AFRICA	470,056	4.82	91.61	20,140	3.16	90.31	4.11
	TOTAL TOP 6	8,929,721	91.61		575,745	90.31		6.06
	ALL REGIONS	9,747,316	100.00		637,479	100.00		6.14

TABLE III-29M. U. S. FOREIGN TRADE VERSUS UNIT VALUE AIR AND TOTAL SEABORNE – 1976 IMPORTS

UNIT VALUE $/Kg	CUM AIR METRIC TONS	CUM VESSEL METRIC TONS	AIR + VESSEL METRIC TONS	AIR + VESSEL / AIR	POTENTIAL(1) AIR PENETRATION %
155.5	4,230	0	4,230	1.0	0.0009
133.3	7,200	0	7,200	1.0	0.001
111.1	8,730	90	8,820	1.01	0.001
88.8	9,900	162	10,062	1.016	0.002
66.6	11,880	360	12,240	1.030	0.002
44.4	63,000	1,080	64,080	1.017	0.013
22.2	105,300	18,000	123,300	1.170	0.026
20	135,000	19,800	154,800	1.146	0.033
17.7	157,500	22,050	179,550	1.140	0.038
15.5	157,500	22,050	179,550	1.140	0.038
13.3	283,500	22,500	306,000	1.079	0.065
11.1	310,500	51,300	361,800	1.165	0.077
8.8	378,000	123,300	501,300	1.326	0.104
6.6	414,000	1,026,000	1,440,000	3.478	0.308
4.4	450,000	1,170,000	1,620,000	3,600	0.347
2.2	522,000	8,100,000	8,622,000	16.517	1.848
2.0	522,000	8,280,000	8,802,000	16.862	1.887
1.8	522,000	8,370,000	8,892,000	17.034	1.906
1.6	523,800	9,810,000	10,333,800	19.728	2.216
1.3	525,600	12,150,000	12,675,600	24.116	2.718
1.1	527,400	13,050,000	13,577,400	25.744	2.911
.8	524,200	14,580,000	15,107,200	28.551	3.240
.6	531,000	18,000,000	18,531,000	34.898	3.973
.4	540,000	19,620,000	20,160,000	37.333	4.323
.2	545,400	39,150,000	39,695,400	72.782	8.513
0	545,470	465,761,520	466,306,990	854.872	100.0

Grand Total – Vessel	465,761,520
Air	545,470
Vessel & Air	466,306,990
Actual Air Penetration – %	.117

(1) Potential air penetration of total trade if air obtained all vessel-borne traffic above given unit value

TABLE III-30M. U. S. FOREIGN TRADE VERSUS UNIT VALUE - AIR AND CONTAINERIZED SEABORNE -1976 IMPORTS

UNIT VALUE $/KG	CUM AIR METRIC TONS	CUM CONT'Z'D VESSEL METRIC TONS	CONT'Z'D AIR + VESSEL METRIC TONS	CONT'Z'D AIR + VESSEL / AIR	POTENTIAL(1) AIR PENETRATION %
155.5	4,230	0	4,230	1.0	0.0009
133.3	7,200	0	7,200	1.0	0.001
111.1	8,730	13.5	8,744	1.001	0.001
88.8	9,900	31.5	9,932	1.003	0.002
66.6	11,880	96.3	11,976	1.008	0.002
44.4	63,000	450.0	63,450	1.007	0.013
22.2	105,300	14,130	119,430	1.134	0.025
20.0	135,000	15,300	150,300	1.113	0.032
17.7	157,500	16,740	174,240	1.106	0.037
15.5	157,500	17,100	174,600	1.108	0.037
13.3	283,500	17,100	300,600	1.060	0.064
11.1	310,500	41,400	351,900	1.133	0.015
8.8	378,000	96,300	474,300	1.254	0.101
6.6	414,000	792,000	1,206,000	2.913	0.258
4.4	450,000	891,000	1,341,000	2.980	0.287
2.2	522,000	3,420,000	3,942,000	7.552	0.845
2.0	522,000	3,528,000	4,050,000	7.758	0.868
1.8	522,000	3,690,000	4,212,000	8.068	0.903
1.6	523,800	4,140,000	4,663,800	8.903	1.000
1.3	525,600	4,860,000	5,385,600	10.240	1.154
1.1	527,400	5,580,000	6,107,400	11.580	1.309
.8	524,200	6,120,000	6,649,200	12.564	1.425
.6	531,000	7,245,000	7,776,000	14.644	1.667
.4	540,000	7,740,000	8,280,000	15.333	1.775
.2	545,400	8,820,000	9,365,400	17.172	2.008
0	545,470	9,607,092	10,152,562	18.612	2.177
INCORPORATING CASE STUDY RESULTS					
.2	545,400	493,020(2)	1,039,320	1.906	0.232
0	545,470	537,998(2)	1,083,468	1.986	0.232

(1) Potential Air Penetration of total trade of Table III-33 if air obtained all containerized vessel-borne traffic above given unit value

(2) 5.6 percent penetration of containerized seaborne trade from Carrier Case Study results

TABLE III-31M. U. S. FOREIGN TRADE VERSUS UNIT VALUE - AIR AND TOTAL SEABORNE 1970 EXPORTS

$/KG	AIR METRIC TONS	VESSEL METRIC TONS	AIR + VESSEL METRIC TONS	AIR + VESSEL / AIR	POTENTIAL(1) AIR PENETRATION OF TOTAL EXPORTS %
155.5	1,620	0	1,620	1.0	.006
133.3	1,890	0	1,890	1.0	.0007
111.1	4,860	0	4,860	1.0	.001
88.8	10,800	4,680	15,480	1.433	.006
66.6	67,500	5,040	72,540	1.074	.028
44.4	151,200	5,400	156,600	1.035	.061
22.2	225,000	22,500	247,500	1.100	.096
20.0	243,000	22,950	265,950	1.094	.104
17.7	288,000	22,950	310,950	1.079	.121
15.5	315,000	32,850	347,850	1.104	.136
13.3	322,200	68,400	390,600	1.212	.153
11.1	324,000	114,300	348,300	1.352	.171
8.8	432,000	128,700	560,700	1.297	.219
6.6	522,000	666,000	1,188,000	1.275	.465
4.4	576,000	2,115,000	2,691,000	9.671	1.054
2.2	612,000	5,580,000	6,192,000	10.117	2.426
2.0	612,000	5,850,000	6,462,000	10.558	2.532
1.8	616,500	6,030,000	6,646,500	10.781	2.604
1.6	621,000	6,300,000	6,921,000	11.144	2.712
1.3	630,000	7,020,000	7,650,000	12.142	2.998
1.1	634,500	9,000,000	9,634,500	15.184	3.775
.8	639,000	11,970,000	12,609,000	19.732	4.941
.6	643,500	13,230,000	13,873,500	21.559	5.437
.4	648,000	19,800 000	20,448,000	31.555	8.013
.2	653,400	47,200,000	48,353,400	74.003	18.951
0	653,681	254,501,000	255,155,400	390.331	100.000

Grand Total - Vessel	254,501,000
Air	653,681
Vessel & Air	255,154,681
Actual Air Penetration - %	.24

(1) Potential air penetration of total trade if air obtained all vessel-borne traffic above given unit value.

TABLE III-32M. U. S. FOREIGN TRADE VERSUS UNIT VALUE - AIR AND CONTAINERIZED SEABORNE - 1976 EXPORTS

UNIT VALUE $/KG.	AIR METRIC TONS	CONT'Z'D VESSEL METRIC TONS	AIR + CONT'Z'D VESSEL METRIC TONS	AIR + VESSEL / AIR	POTENTIAL(1) AIR PENETRATION
155.5	1,620	0	1,620	1.000	.0006
133.3	1,890	0	1,890	1.000	.0007
111.1	4,860	0	4,860	1.000	.001
88.9	10,800	3,870	14,670	1.358	.005
66.6	67,500	3,960	71,460	1.058	.028
44.4	151,200	4,140	155,340	1.027	.060
22.2	225,000	8,640	233,640	1.038	.091
20.0	243,000	8,820	251,820	1.036	.098
17.7	288,000	9,000	297,000	1.031	.116
15.5	315,000	13,770	328,770	1.043	.128
13.3	322,200	31,950	354,150	1.099	.138
11.1	324,000	55,800	379,800	1.172	.148
8.8	432,000	63,000	495,000	1.145	.193
6.6	522,000	270,000	792,000	1.517	.310
4.4	576,000	738,000	1,314,000	2.281	.514
2.2	612,000	1,125,000	2,637,000	4.308	1.033
2.0	612,000	2,160,000	2,772,000	4.529	1.086
1.8	614,500	2,250,000	2,866,500	4.649	1.123
1.6	621,000	2,313,000	2,934,000	4.724	1.149
1.3	630,000	2,340,000	2,970,000	4.714	1.163
1.1	634,500	3,195,000	3,829,500	6.035	1.500
.8	639,000	4,140,000	4,779,000	7.478	1.872
.6	643,500	4,770,000	5,413,500	8.412	2.121
.4	648,000	5,850,000	6,498,000	10.027	2.546
.2	653,500	8,100,000	8,753,400	13.397	3.431
0	653,800	10,407,000	11,061,000	16.921	4.335

INCORPORATING CASE STUDY RESULTS

.22	653,400	453,600(2)	1,107,000	1.694	0.434
0	653,682	582,801(2)	1,236,489	1.892	0.485

(1) Potential Air Penetration of total trade of Table III-35 if air obtained all containerized vessel-borne traffic above given unit value.

(2) 5.6 percent penetration of containerized seaborne trade from Carrier Case Study results

TABLE III-47M. SUMMARY COMPARISONS OF OECD DATA ANALYSES

OECD/DOC/MARAD COMPARISON - SEABORNE CONTAINERIZABLE

METRIC TONS (MILLIONS)

	1973	1974	1975	1980	1985	1990	1995	2000
IMPORTS								
OECD (U. S. ONLY)	93.0	80.2	64.3	88.6	102.6	119.5	137.3	155.8
DOC	N.A.	61.0	N.A.	68.0	75.9	85.2	96.2	109.3
MARAD	62.5	61.1	51.1	73.7	91.1	95.2	130.4	165.2
EXPORTS								
OECD (U. S. ONLY)	107.4	93.8	76.7	109.1	126.3	144.4	162.9	181.8
DOC	N.A.	100.2	N.A.	125.5	153.5	188.2	231.4	286.2
MARAD	99.5	100.2	94.7	125.9	159.5	197.0	249.7	318.9
IMPORTS & EXPORTS								
OECD (U. S. ONLY)	200.4	174.0	141.1	197.9	228.9	263.9	300.2	337.7
DOC	N.A.	161.1	N.A.	193.5	229.5	273.3	327.6	395.4
MARAD	162.0	161.3	145.8	199.6	250.3	302.0	379.9	484.1

TABLE III-48M. SUMMARY COMPARISONS OF OECD DATA ANALYSES

OECD/DOC/MARAD COMPARISON - SEABORNE CONTAINERIZED

	1973	1974	1975	1980	1985	1990	1995	2000
				METRIC TONS (MILLIONS)				
IMPORTS								
OECD (U. S. ONLY)	23.0	15.0	12.1	15.0	16.9	19.6	22.5	25.5
DOC	N.A.	9.2	N.A.	11.8	14.6	18.3	23.0	29.3
MARAD	9.3	9.0	7.7	11.7	14.8	18.1	23.1	30.0
EXPORTS								
OECD (U. S. ONLY)	16.4	11.7	9.3	13.2	15.2	17.4	19.6	22.0
DOC	N.A.	10.8	N.A.	13.2	16.1	19.8	24.6	31.2
MARAD	9.7	10.4	9.7	12.9	16.0	19.5	24.4	30.9
IMPORTS & EXPORTS								
OECD (U. S. ONLY)	39.5	26.6	21.4	28.2	32.0	37.0	42.1	47.4
DOC	N.A.	20.0	N.A.	25.0	30.8	38.1	47.6	60.6
MARAD	19.0	19.5	17.4	24.7	30.8	37.6	47.5	61.1

TABLE III-49M. SUMMARY COMPARISONS OF OECD DATA ANALYSES

OECD/DOC COMPARISON - CONVENTIONAL AIRBORNE

METRIC TONS (THOUSANDS)

	1973	1974	1975	1980	1985	1990	1995	2000
IMPORTS								
OECD (U. S. ONLY)	1269.2	805.9	655.3	961.5	1227.1	1542.4	1839.5	2116.6
DOC	N.A.	479.7	N.A.	830.8	1179.8	1574.4	2012.0	2490.8
EXPORTS								
OECD (U. S. ONLY)	1150.3	1043.1	619.2	951.5	1175.7	1419.7	1673.5	1944.2
DOC	N.A.	705.5	N.A.	925.9	1242.5	1596.3	1996.6	2459.5
IMPORTS & EXPORTS								
OECD (U. S. ONLY)	2419.5	1848.9	1274.4	1912.9	2402.8	2962.0	3513.0	4060.8
DOC	N.A.	640.0	N.A.	1756.7	2422.3	3170.7	4008.7	4950.2

TABLE III-53M. U. S. - WORLD RELATIONSHIP SUMMARY FROM OECD DATA ANALYSES

SEABORNE-CONTAINERIZABLE

	1973	1974	1975	1980	1985	1990	1995	2000
	METRIC TONS (MILLIONS) AND PERCENT							
IMPORTS								
U. S. ONLY	93.0	80.2	64.3	88.6	102.6	119.5	137.3	155.8
WORLD TOTAL	209.6	186.5	134.6	176.9	197.0	224.8	255.2	286.6
U. S. - PERCENT	44.4	43.0	47.8	50.1	52.1	53.1	53.8	54.4
EXPORTS								
U. S. ONLY	107.4	93.6	76.7	109.1	126.3	144.4	162.9	181.8
WORLD TOTAL	212.9	202.0	180.8	217.2	246.9	280.0	315.2	352.7
U. S. - PERCENT	50.4	46.3	42.4	50.3	51.1	51.6	51.7	51.5
IMPORTS & EXPORTS								
U. S. ONLY	200.4	173.7	141.1	197.9	228.9	263.9	300.2	337.7
WORLD TOTAL	422.5	388.5	315.4	394.1	444.0	504.8	570.4	638.6
U. S. - PERCENT	47.4	44.7	44.7	50.2	51.6	52.3	52.6	52.9

TABLE III-54M. U. S. - WORLD RELATIONSHIP SUMMARY FROM OECD DATA ANALYSIS

SEABORNE - CONTAINERIZED

METRIC TONS (MILLIONS) AND PERCENT

	1973	1974	1975	1980	1985	1990	1995	2000
IMPORTS								
U. S. ONLY	23.0	15.0	12.1	15.0	16.9	19.6	22.5	22.5
WORLD TOTAL	39.0	28.8	21.0	26.6	29.6	34.2	39.4	44.7
U. S. - PERCENT	59.1	51.9	57.3	56.3	57.1	57.3	57.1	57.0
EXPORTS								
U. S. ONLY	16.4	11.6	9.3	13.2	15.2	17.4	19.6	22.0
WORLD TOTAL	42.8	28.8	25.9	34.4	38.7	43.7	49.1	54.7
U. S. - PERCENT	38.3	40.3	36.0	38.5	39.3	39.8	39.9	40.1
IMPORTS & EXPORTS								
U. S. ONLY	39.5	26.6	21.4	28.2	32.0	37.0	42.1	47.4
WORLD TOTAL	81.8	57.7	47.0	61.0	68.3	78.0	88.5	99.5
U. S. - PERCENT	48.2	46.1	45.6	46.3	46.9	47.4	47.5	47.7

TABLE III-55M. U. S. - WORLD RELATIONSHIP SUMMARY FROM OECD DATA ANALYSES

CONVENTIONAL AIRBORNE

	1973	1974	1975	1980	1985	1990	1995	2000
			METRIC TONS (THOUSANDS) AND PERCENT					
IMPORTS								
U. S. ONLY	1269.2	805.9	655.3	961.5	1227.1	1542.4	1839.5	2116.6
WORLD TOTAL	2164.3	1810.0	1190.3	1771.9	2216.6	2740.7	3250.8	3718.1
U. S. - PERCENT	58.6	44.5	55.0	54.3	55.4	56.3	56.6	56.9
EXPORTS								
U. S. ONLY	1150.3	1043.1	619.2	951.5	1175.7	1419.7	1673.5	1944.3
WORLD TOTAL	2746.0	2217.5	1600.6	2520.2	3101.6	3678.3	4239.9	4789.8
U. S. - PERCENT	41.9	47.0	38.7	37.8	37.9	38.6	39.5	40.6
IMPORTS & EXPORTS								
U. S. ONLY	2419.5	1848.9	1274.4	1912.9	2402.8	2962.0	3513.0	4060.8
WORLD TOTAL	4910.3	4027.5	2791.0	4292.2	5318.2	6419.0	7490.8	8507.9
U. S. - PERCENT	49.3	45.9	45.7	44.6	45.2	46.1	46.9	47.7

C-4

APPENDIX III-D

U.S. SEABORNE TRADE LONG-TERM FORECAST: CONTAINERIZABLE CARGO

Containerizable Commodities Analysis

This Appendix contains Tables 29 and 30 from Supplement A. Supplement A is bound separately and may be obtained from NASA, Langley. Supplement A contains output from the Maritime Administration's U.S. Seaborne Trade long-term forecast for the total seaborne tonnage of all commodities at the three digit level.

An output tape was obtained from the Maritime Administration of their Long-Term World Forecast. For the CLASS Study analyses a rearrangement of the output was made, and is presented in Supplement A Tables 1 and 2 for U.S. World imports and exports, respectively, and in Tables 3 through 28 for 13 U.S. trading partner regions. The tables in Supplement in Supplement A are listed below:

List of Tables Contained in Supplement A

Table No.	Title
1	U.S. World Imports
2	U.S. World Exports
3	Region 01 - Canada - Imports
4	Region 01 - Canada - Exports
5	Region 02 - OECD Europe - Imports
6	Region 02 - OECD Europe - Exports
7	Region 03 - Other Free Europe - Imports
8	Region 03 - Other Free Europe - Exports
9	Region 04 - Japan - Imports
10	Region 04 - Japan - Exports
11	Region 05 - Australia - Imports
12	Region 05 - Australia - Exports
13	Region 06 - New Zealand - Imports
14	Region 06 - New Zealand - Exports
15	Region 07 - Middle East - Imports
16	Region 07 - Middle East - Exports

Table No.	Title
17	Region 08 - Africa - Imports
18	Region 08 - Africa - Exports
19	Region 09 - Less Developed Asia - Imports
20	Region 09 - Less Developed Asia - Exports
21	Region 10 - Less Developed America - Imports
22	Region 10 - Less Developed America - Exports
23	Region 11 - Communist Europe - Imports
24	Region 11 - Communist Europe - Exports
25	Region 12 - Communist Asia - Imports
26	Region 12 - Communist Asia - Exports
27	Region 13 - All Other Countries - Imports
28	Region 13 - All Other Countries - Exports
29	Rate of Containerization - Imports
30	Rate of Containerization - Exports

The original MarAd Forecast was arranged in numerical order of the commodity Standard International Trade Classification code number. The commodities have been regrouped based on a MarAd study - "Preliminary Assessment of Cargo Containerization in U.S. Oceanborne Foreign Trade." This analysis of 1974 levels of containerization defines commodities as bulk or containerized. Bulk commodities are either dry bulk or liquid bulk, and at the 3-digit level had zero containerization. The containerized commodities are divided into levels of containerization as follows: 0 to 5 percent, 5 to 20 percent, 20 to 40 percent, 40 to 60 percent, and 60 to 100 percent. These levels of containerization by commodity are presented in Tables 29 and 30 for import and exports, respectively. The data presented in this Appendix and Supplement A are the basic MarAd Long-Term World Forecasts at the 3-digit level rearranged according to the bulk/containerization divisions, and thus represent the containerizable tonnage. Supplement B, described in Appendix III-E, presents the containerized tonnages. The containerized tonnages are obtained by multiplying the containerizable tonnage by the mean of the respective range of containerization.

TABLE 29-1. RATE OF CONTAINERIZATION -- 3-DIGIT CENSUS SCHEDULE A & B

SCHEDULE A IMPORTS

		Percent Containerized					
Code	Commodity Description	Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
001	Live Animals						X
011	Meat, Fresh, Chilled or Frozen					X	
012	Pork, Drd, Sltd, Smoked					X	
013	Meats in Containers, N.E.S.					X	
022	Milk and Cream						X
023	But. & Cream over 45% B. Fat						X
024	Cheese and Curd						X
025	Eggs, Birds, Albumen & Yolk					X	
031	Fish, Fresh, or Simply Preserved				X		
032	Fish, Airtight Cont., N.E.C.					X	
041	Wheat, Unmilled	X					
042	Rice Including Patna						X
043	Barley, Unmilled	X					
044	Corn or Maize, Unmilled	X					
045	Cereals, Unmilled, N.E.S.						X
048	Cereal and Flour Preparations						X
051	Fruits, Fresh			X			
052	Fruits, Dried				X		
053	Nuts & Fruits, N.E.S.				X		
054	Vegetables, Fresh, Chlo, Frzn.				X		
055	Vegetables, Preserved N.E.S.					X	
061	Sugar, Syrups, Molasses, Honey	X					
062	Sugar, Confectionery						X
071	Coffee		X				
072	Cocoa			X			
073	Chocolate						X
074	Tea & Mate				X		
075	Spices				X		
081	Feeding-Stuff for Animals			X			
091	Lard and Butter Substitutes						X
099	Food Preparations, N.E.C.						X
111	Nonalcoholic Beverages, N.E.C.						X
112	Alcoholic Beverages						X
121	Tobacco, Unmanufactured			X			
122	Tobacco, Manufactures						X

TABLE 29-2. RATE OF CONTAINERIZATION - 3-DIGIT CENSUS SCHEDULE A & B

SCHEDULE A IMPORTS

Code	Commodity Description	Percent Containerized Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
211	Hides & Skins, Undressed					X	
212	Fur Skins, Undressed						X
221	Oil Seeds, Oil Nuts, Kernels		X				
231	Rubber Crude			X			
241	Fuel Wood, Charcoal, and Waste			X			
242	Wood, In the Rough		X				
243	Wood, Shaped or Simply Worked		X				
244	Cork, Natural, Raw and Waste			X			
251	Pulps and Waste Paper		X				
261	Silk, Raw			X			
262	Wool and Other Animal Hair						X
263	Cotton			X			
264	Jute			X			
265	Fibers, Vegetable N.E.S.			X			
266	Man Made Fibers					X	
267	Waste from Textile Fabrics				X		
271	Fertilizers, Crude	X					
273	Stone, Sand, and Gravel	X					
274	Sulphur and Crude Iron Pyrites	X					
275	Natural Abrasives, Inc. Diamon		X				
276	Crude Minerals N.E.S.		X				
281	Iron Ore and Concentrates	X					
282	Iron and Steel Scrap			X			
283	Ores, Concentrates Nonferrous	X					
284	Nonferrous Metal Scrap			X			
285	Platinum		X				
286	Thorium Ores and Concentrates		X				
291	Animal Materials, NES, Crude				X		
292	Vegetable Materials NES, Crude			X			
321	Coal, Coke and Briquets	X					
331	Petroleum, Crude	X					
332	Petroleum, Products	X					
341	Gas, Natural & Manufactured	X					
411	Animal Oils and Fats N.E.S.				X		
421	Fixed Vegetable Oils, Soft				X		
422	Fixed Vegetable Oils, N.E.C.		X				
431	Fatty Acids, Waxes, Fats, Oils				X		

TABLE 29-3. RATE OF CONTAINERIZATION - 3-DIGIT CENSUS SCHEDULE A&B

SCHEDULE A IMPORTS

		Percent Containerized					
Code	Commodity Description	Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
512	Organic Chemicals			X			
513	Inorganic Chemical Elements		X				
514	Inorganic Chem. Except Elements				X		
515	Radioactive-Stable Isotopes						X
521	Mineral Tar and Tar Oils	X					
531	Synthetic Organic Dyestuffs						X
532	Dyeing and Tanning Extracts			X			
533	Pigments, Paints, Varnish						X
541	Medic and Pharmac. Products						X
551	Essential Oils, Perfume				X		
553	Perfumes, Cosmetics, Dentifric						X
554	Soaps and Polishing Preps						X
561	Fertilizers, Manufactured		X				
571	Explosives & Pyrotechnic Pro.					X	
581	Plastic Materials, Syn. Resins						X
599	Chem. Prods & Mtls. N.E.C.					X	
611	Leather				X		
612	Manufactures of Leather N.E.C.						X
613	Fur Skins, Dressed						X
629	Rubber, Mfgrs. Finished NEC						X
631	Wood Veneers, Plywood Boards		X				
632	Wood Manufactures, N.E.C.					X	
633	Cork Manufactures			X			
641	Paper and Paperboard		X				
642	Articles & Paper Pulp, Paper						X
651	Textile Yarn and Thread						X
652	Cotton Fabrics, Woven				X		
653	Textile Fabrics, Woven			X			
654	Tulle, Lace, Embroidery, Etc.				X		
655	Special Textile Fabrics, Incl			X			
656	Made-up Articles, Textile, N.E.C.					X	
657	Floor Covering, Tapestries Etc.						X
661	Building Material, Lime, Cement		X				
662	Clay and Ref. Constru Material					X	
663	Mineral Manufactures, N.E.C.					X	
664	Glass					X	
665	Glassware						X

TABLE 29-4. RATE OF CONTAINERIZATION - 3-DIGIT CENSUS SCHEDULE A&B

SCHEDULE A IMPORTS

		Percent Containerized					
Code	Commodity Description	Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
666	Pottery						X
667	Precious, Semi-Precious Stones			X			
661	Pig Iron		X				
672	Iron or Steel Primary Forms		X				
673	Iron or Steel Bars		X				
674	Iron or Steel Plates & Sheets		X				
675	Hoop & Strip of Iron or Steel				X		
676	Rails or Railway Track Material		X				
677	Iron or Steel Wire, Excl.				X		
678	Iron or Steel Tubes, Fittings			X			
679	Iron or Steel Castings, Forging					X	
681	Silver and Platinum			X			
682	Copper & Copper Alloy			X			
683	Nickel & Nickel Alloys Etc.					X	
684	Aluminum & Aluminum Alloys				X		
685	Lead & Lead Alloys			X			
686	Zinc & Zinc Alloys			X			
687	Tin & Tin Alloys			X			
688	Uranium & Thorium Metal						X
689	Non Ferrous Base Metal N.E.C.				X		
691	Fin. Structural Metal Parts NEC				X		
692	Metal Containers for Storage				X		
693	Wire Pro. Non Electric Fencing				X		
694	Nails, Screw, Nuts, Bolts, Etc.				X		
695	Hand and Machine Tools					X	
696	Table Flatware and Cutlery						X
697	Household Equip. of Base Metal						X
698	Manufactures of Metal, N.E.C.					X	
711	Power Generating Machinery						X
712	Agricultural Machinery, Etc.				X		
714	Office Machines and Parts						X
715	Metalworking Machinery & Parts					X	
717	Textile & Leather Machinery						X
718	Mach. for Spec Industr.					X	
719	Mach. & Appliance N.E.C.					X	
722	Electric Power Machinery						X
723	Equip. for Distributing Elec.					X	

TABLE 29-5. RATE OF CONTAINERIZATION - 3-DIGIT CENSUS SCHEDULE A&B

SCHEDULE A IMPORTS

		Percent Containerized					
Code	Commodity Description	Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
724	Telecommunications Apparatus						X
725	Electric Refrigerators						X
726	Electric Apparatus, Medical						X
729	Electrical Machinery N.E.S.						X
731	Railway Vehicles and Parts				X		
732	Road Motor Vehicles and Parts			X			
733	Vehicles Other Than Road Mtr						X
734	Aircraft & Spacecraft					X	
735	Ships, Boats, Floating Struct.					X	
812	Plumb. Heating, Equip Lightfix						X
821	Furniture						X
831	Travel Goods, Handbags, Etc.						X
841	Clothing, Etc. Not Fur						X
842	Fur Clothing Incl.						X
851	Footwear						X
861	Scientific, Med. Apparat. N.E.C.						X
862	Photographic Supplies, Incl.						X
863	Motionpicture, Photofilm N.E.C.						X
864	Watches & Clocks Parts Incl.						X
891	Sound Recorders and Parts						X
892	Printed Matter						X
893	Plastic Manufactures, N.E.C.						X
894	Baby Carriages, Toys, Games						X
895	Office & Stationery Supplies						X
896	Works of Art, Antiques						X
897	Jewelry and Related Articles					X	
899	Manufactured Articles, N.E.C.						X
931	Spec. Transactions Not Class.				X		
941	Animals - Live - N.E.C. Incl		X				
951	Armored Fighting Vehicles, Arms						X
999	All Other Commodities			X			

TABLE 30-1. RATE OF CONTAINERIZATION -- 3-DIGIT CENSUS SCHEDULE A & B

SCHEDULE B EXPORTS

Code	Commodity Description	Percent Containerized Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
001	Live Animals			X			
011	Meat, Fresh, Chilled or Frozen					X	
012	Meat, Dried, Slted, or Smoked				X		
013	Meat in Cont, N.E.S.				X		
022	Milk and Cream					X	
023	Butter and Anhydrous Milk Fat					X	
024	Cheese and Curd					X	
025	Eggs, Birds, Excl. Egg Album.						X
031	Fish, Fresh or Simply Preserved					X	
032	Fish, Airtight Cont., N.E.C.					X	
041	Wheat, Unmilled	X					
042	Rice		X				
043	Barley, Unmilled	X					
044	Corn or Maize, Unmilled	X					
045	Cereals, Unmilled, N.E.S.	X					
046	Wheat Flour, Meal, and Groats	X					
047	Cereal Flour, Meal and Groats	X					
048	Cereal and Flour Preparations			X			
051	Fruits, Fresh				X		
052	Fruits, Dried					X	
053	Nuts & Fruits, N.E.S.					X	
054	Vegetables, Fresh, Chld, Frzn.					X	
055	Vegetables, Preserved N.E.S.					X	
061	Sugar, Syrups, Molasses, Honey			X			
062	Sugar, Confectionery					X	
071	Coffee			X			
072	Cocoa				X		
073	Chocolate					X	
074	Tea and Mate					X	
075	Spices				X		
081	Feeding-Stuff for Animals		X				
091	Margarine and Edible Fats			X			
099	Food Preparations, N.E.C.				X		
111	Nonalcoholic Beverages, N.E.C.					X	
112	Alcoholic Beverages					X	
121	Tobacco, Unmanufactured					X	
122	Tobacco Manufactures				X		

TABLE 30-2. RATE OF CONTAINERIZATION -- 3-DIGIT CENSUS SCHEDULE A & B

SCHEDULE B EXPORTS

Code	Commodity Description	Percent Containerized Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
211	Hides & Skins, Undressed					X	
212	Fur Skins, Undressed					X	
221	Oil Seeds, Oil Nuts, Kernels		X				
231	Rubber Crude				X		
241	Fuel Wood, Charcoal, and Waste		X				
242	Wood, In the Rough		X				
243	Wood, Shaped or Simply Worked		X				
244	Cork, Natural, Raw and Waste					X	
251	Pulps and Waste Paper				X		
261	Silk, Raw					X	
262	Wool and Other Animal Hair						X
263	Cotton				X		
264	Jute				X		
265	Fibers, Vegetable N.E.S.						X
266	Man Made Fibers						X
267	Waste From Textile Fabrics					X	
271	Fertilizers, Crude	X					
273	Stone, Sand, and Gravel	X					
274	Sulphur and Crude Iron Pyrites	X					
275	Natural Abrasives, Inc. Diamond					X	
276	Crude Minerals N.E.S.			X			
281	Iron Ore and Concentrates	X					
282	Iron and Steel Scrap		X				
283	Ores, Concentrates Nonferrous						
284	Nonferrous Metal Scrap					X	
285	Platinum						X
286	Uranium, Thorium Ores & Cons.		X				
291	Animal Materials, NES, Crude					X	
292	Vegetable Materials NES, Crude				X		
321	Coal, Coke and Briquets	X					
331	Petroleum, Crude	X					
332	Petroleum, Products			X			
341	Gas, Natural & Manufactured	X					
411	Animal Oils and Fats N.E.S.		X				
421	Fixed Vegetable Oils, Soft		X				
422	Fixed Vegetable Oils, N.E.C.			X			
431	Fatty Acids, Waxes, Fats, Oils				X		

TABLE 30-3. RATE OF CONTAINERIZATION -- 3-DIGIT CENSUS SCHEDULE A & B

SCHEDULE B EXPORTS

		Percent Containerized					
Code	Commodity Description	Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
512	Organic Chemicals			X			
513	Inorganic Chemical Elements		X				
514	Inorganic Chem. Except Elements			X			
515	Radioactive & Stable Isotopes						X
521	Mineral Tar and Tar Oils	X					
531	Synthetic Organic Dyestuffs						X
532	Dyeing and Tanning Extracts			X			
533	Pigments, Paints, Varnish				X		
541	Medic and Pharmac. Products				X		
551	Essential Oils, Perfume					X	
553	Perfumes, Cosmetics, Dentrifrices					X	
554	Soaps and Polishing Preps				X		
561	Fertilizers, Manufactured		X				
571	Explosives & Pyrotechnic Pro.				X		
581	Plastic Materials, Syn. Resins					X	
599	Chem. Prods. & Mtls. N.E.C.			X			
611	Leather					X	
612	Manufactures of Leather N.E.C.				X		
613	Fur Skins, Dressed				X		
621	Rubber Manufactures, Unvulcaniz				X		
629	Rubber, Mfgrs. Finished NEC				X		
631	Wood Veneers, Plywood Boards		X				
632	Wood Manufactures, NEC						X
633	Cork Manufactures			X			
641	Paper and Paperboard			X			
642	Articles & Paper Pulp, Paper				X		
651	Textile Yarn and Thread						X
652	Cotton Fabrics, Woven						X
653	Textile Fabrics, Woven				X		
654	Tulle, Lace, Embroidery, Etc.				X		
655	Special Textile Fabrics, Incl				X		
656	Made-Up Articles, Textile, NEC						X
657	Floor Covering, Tapestries Etc.						X
661	Building Material, Lime, Cement			X			
662	Clay and Ref. Constru Material				X		
663	Mineral Manufactures, N.E.C.					X	
664	Glass					X	

TABLE 30-4. RATE OF CONTAINERIZATION -- 3-DIGIT CENSUS SCHEDULE A & B

SCHEDULE B EXPORTS

Code	Commodity Description	Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
665	Glassware						X
666	Pottery				X		
667	Precious, Semi-Precious Stones					X	
671	Pig Iron			X			
672	Iron or Steel Primary Forms		X				
673	Iron or Steel Bars		X				
674	Iron or Steel Plates & Sheets			X			
675	Hoop & Strip of Iron or Steel			X			
676	Rails or Railway Track Material		X				
677	Iron or Steel Wire, Excl.				X		
678	Iron or Steel Tubes, Fitrings		X				
679	Iron or Steel Castings, Forging				X		
681	Silver and Platinum				X		
682	Copper & Copper Alloy				X		
683	Nickel & Nickel Alloys Etc.					X	
684	Aluminum & Aluminum Alloys					X	
685	Lead & Lead Alloys				X		
686	Zinc & Zinc Alloys			X			
687	Tin & Tin Alloys					X	
688	Uranium & Thorium Metal		X				
689	Non Ferrous Base Metal N.E.C.				X		
691	Fin. Structural Metal Parts NE			X			
692	Metal Containers for Storage				X		
693	Wire Pro. Non Electric Fencing			X			
694	Nails, Screw, Nuts, Bolts, Etc.				X		
695	Hand and Machine Tools				X		
696	Table Flatware and Cutlery					X	
697	Household Equip. of Base Metal					X	
698	Manufactures of Metal, NEC				X		
711	Power Generating Machinery				X		
712	Agricultural Machinery, Etc.				X		
714	Office Machines and Parts					X	
715	Metalworking Machinery & Parts				X		
717	Textile & Leather Machinery					X	
718	Mach. for Spec Industr.				X		
719	Mach. & Appliance N.E.C.				X		
722	Electric Power Machinery				X		

TABLE 30-5. RATE OF CONTAINERIZATION -- 3-DIGIT CENSUS SCHEDULE A & B

SCHEDULE B EXPORTS

		Percent Containerized					
Code	Commodity Description	Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
723	Equip. for Distributing Elec.				X		
724	Telecommunications Apparatus					X	
725	Electric Refrigerators					X	
726	Electric Apparatus, Medical			X			
729	Electrical Machinery N.E.S.				X		
731	Railway Vehicles and Parts			X			
732	Road Motor Vehicles and Parts				X		
733	Vehicles Other Than Road Mtr					X	
734	Aircraft and Spacecraft				X		
735	Ships, Boats, Floating Struct			X			
812	Plumb. Heating, Equip Lightfix					X	
821	Furniture					X	
831	Travel Goods, Handbags, Etc.					X	
841	Clothing, Etc. Not Fur					X	
842	Fur Clothing Incl.						X
851	Footwear					X	
861	Scientific, Med. Apparat. N.E.C.					X	
862	Photographic Supplies, Inc.						X
863	Motionpicture, Photofilm N.E.C.				X		
864	Watches & Clocks Parts Incl.						X
891	Sound Recorders and Parts						X
892	Printed Matter					X	
893	Plastic Manufactures, N.E.C.					X	
894	Baby Carriages, Toys, Games					X	
895	Office & Stationery Supplies					X	
896	Works of Art, Antiques						X
897	Jewelry and Related Articles				X		
899	Manufactured Articles, N.E.C.					X	
931	Spec. Transactions not Class.			X			
941	Animals. Live. N.E.C. Incl						X
951	Armored Fighting Vehicles, Arms						X
952	Military Apparel and Footwear						X
961	Coin, Other than Gold		X				
999	All Other Commodities			X			

APPENDIX III-E

U.S. SEABORNE TRADE LONG-TERM FORECAST: CONTAINERIZED CARGO

Containerized Commodities Analysis

This appendix describes the contents of Supplement B, which is bound separately and may be obtained from NASA, Langley.

The containerized tonnages in Supplement B are based on the containerizable tonnages of Supplement A, described in Appendix III-D, multiplied by the respective levels of containerization.

For Example:

U.S. World Imports for 1975

Commodity 121 - Tobacco, Unmanufactured

Metric Tons - 167,982

Containerization - 5 - 20 percent

Average Containerization - 12.5 percent

Containerized Tonnage - 20,998

Some commodities, for example Imports 661 - Building Material, Lime, Cement, are given specific degrees of containerization. In such cases, this specific degree of containerization was used rather than the average of the range in which the commodity lies. The commodities that have such specific degrees of containerization are:

Imports

661 Building Material Lime, Cement	1.1 percent
231 Rubber Crude	5.0 percent
653 Textile Fabrics, Woven	10.0 percent

Exports

081 Feeding - Stuff for Animals	3.25 percent
221 Oil Seeds, Oil Nuts, Kernals	0.36 percent
242 Wood in the Rough	0.48 percent
411 Animal Oils and Fats NES	4.6 percent
513 Inorganic Chemical Elements	2.7 percent
631 Wood Veneers, Plywood Boards	0.1 percent

641 Paper and Paperboard 15.1 percent

The original data on the MarAd tape was in long tons with totals for regions and world in thousands of long tons. To meet contractual requirements of the CLASS Study and be compatible with other data sources, the output was prepared in short tons and metric tons, with thousands of short tons and metric tons for totals for regions and world. Only metric ton data are presented in the supplements. Conversions are:

Short tons = 1.120 x long tons

Metric tons = 1.0160469 x long tons

A complete list of the tables contained in Supplement B is given below:

List of Tables Contained in Supplement B

APPENDIX III-F

FREE-WORLD INTERNATIONAL CARGO DEMAND

OECD Data Analysis - Country/Region - Pair Choice

This Appendix describes the information contained in Supplement C which is bound separately and may be obtained from NASA Langley. Tables I-1 through I-14-4 from Supplement C are also contained in this Appendix. A complete list of the tables contained in Supplement C is given below

List of Tables Contained in Supplement C

Table	Title
I-1 to 13	Country/Region-Pair Choice
I-14	Rate of Containerization - Schedule A & B, Imports and Exports
II-VI	OECD Data Analyses(1)
II-1 to 33	Free-World International Cargo Demand
III-1 to 33	U.S. International Cargo Demand
IV-1 to 33	OECD Europe International Cargo Demand
V-1 to 33	Japan International Cargo Demand
VI-1 to 33	Macro Regional Group Cargo Demand

(1) Each of the Sections II - VI are divided as follows:

Table No.	Title
1 to 3	OECD All-Modes Total Cargo by Trading Partners and Degrees of Containerization
1	Imports
2	Exports
3	Imports and Exports
4 to 6	OECD All Modes Total Cargo by Trading Partners - Summary
4	Imports
5	Exports
6	Imports and Exports

Table No.	Title
24	Imports and Exports
25 to 27	Containerized Seaborne Cargo as Percent of Containerizable Seaborne Cargo
25	Imports
26	Exports
27	Imports and Exports
28 to 30	Advanced Cargo System Demand by Trading Partners
28	Imports
29	Exports
30	Imports and Exports
31 to 33	Total Air Cargo Demand
32	Exports
33	Imports and Exports

The Organization for Economic Co-operation and Development (OECD) is an organization of the industrial countries. The member countries are the United States of America, Canada, Japan, Australia, New Zealand and 19 European countries - Austria, Belgium-Luxembourg, Denmark, Finland, France, Germany (F.R.), Greece, Iceland, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

The OECD member countries trade with one another and most other countries of the world. Trade data are collected by each member country and consolidated by the OECD and are then made available to the public.

The OECD trade data are available in published form and on computer tape. The Series C reports provide only value data at the 1- and 2-digit levels of commodities and value and quantity at the 3- and 4-digit levels of commodities.

To understand the OECD data and the relative magnitudes of the foreign trade of the OECD member countries and their trading partners, a cursory analysis has been made of the 1974 data.

Summary data for all commodities are presented in Tables I-1 and -2 for imports and exports, respectively. The data are shown for six major reporting countries or country groups - U.S., Canada, OECD Europe, Japan, Australia, and

New Zealand, trading with 10 countries or geographic areas, to establish the major trading routes or partners. These 10 areas include the 6 OECD reporting country groups plus 4 non-OECD areas - Middle East, Africa, Less-Developed Far East (this area excludes Japan and Australasia), and Latin America. The trade value of these trading partners accounts for 90 percent of OECD imports from the entire world and almost 85 percent of OECD exports to the entire world. These data, including the world data, exclude the trade within OECD Europe.

The matrix of trading partners in Tables I-1 and -2 results in 35 trading partner combinations, presented in Table I-3. In arriving at the total trade flow in both directions for each of the 35 trading partner combinations, care was taken to avoid double accounting by not adding Imports and Exports for every combination in Tables I-1 and I-2. For example, from Table I-1, U.S. Imports from Canada and Canadian Imports from the U.S., account for the total two-way flow for that trading partner combination, and hence the export data would give double accounting. No such problem exists with the trading partner combinations involving a non-OECD country or region.

In Table I-4, the 35 trading partners combinations presented in Table I-3 are ranked based on the total two-way trade value for all commodities. The results show that the top 5 trading partner combinations account for over 50 percent of the total value of trade of the 35 combinations. The top 25 account for almost 99 percent. Another significant fact is that 20 out of the 35 trading partner combinations are with non-OECD partners and that these 20 account for over 60 percent of the total value of trade.

Tables I-1 through I-4 address total trade value of all commodities, and clearly petroleum is a significant commodity, particularly with the non-OECD countries. Of the $431 billion total trade flow given in Table I-4, Commodity Group 3 - Mineral Fuels, Lubricants and Related Materials, accounts for over 24 percent or $106 billion.

Tables I-5 through I-8 present the same analysis for commodity group 3 only. Table I-8 shows that non-OECD trading partners account for almost 90 percent of the value of commodity group 3, with the top 3 trading partners accounting for almost 65 percent.

Tables I-9 through -12 present the results of subtracting commodity group 3 from the all-commodity data. These data show that the total value of trade for the 35 trading partner combinations amounts to almost $328 billion. The top 10 trading partner combinations account for over 76 percent of the trade value. The OECD member countries partnered with non-OECD countries account for over 51 percent.

Table I-13 summarizes the trade value for the OECD member country or geographic area. The data show the predominance of the U.S., however, the picture is somewhat distorted for the OECD members lower in the list for all trading partners, since trade with OECD member countries higher in the list is included in that higher-listed country. This, of course, does not apply in

TABLE I-1. MAJOR WORLD TRADE ROUTES - IMPORTS - 1974
ALL COMMODITIES

$ Million

Reporting Countries Trade With	U.S.	Canada	OECD Europe	Japan	Australia & New Zealand Aust.	 N.Z.	OECD Total
U. S.	-	21,751	30,268	12,686	2,282	•	66,987
Canada	22,282	-	5,464	2,663	331	•	30,740
OECD Europe	23,488	3,832	-	5,164	3,646	•	36,130
Middle East	4,665	1,306	39,356	15,319	812	•	61,458
Africa	5,973	273	25,241	2,149	65	•	33,701
Japan	12,455	1,459	7,593	-	2,039	•	23,546
L/Dev Far East	10,264	720	8,386	12,466	1,059	•	32,895
Australia	1,083	343	2,463	4,335	-	•	8,224
New Zealand	348	78	968	401	259	•	2,054
Latin America	13,678	1,870	11,023	2,657	87	•	29,315
Total	94,235	31,632	130,762	57,841	10,580	•	325,050
World	100,972	32,295	154,432	62,035	11,087	•	360,822
Total % of World	93.3	97.9	84.7	93.2	95.4	•	90.1
Non OECD Total	34,580	4,169	84,006	32,591	2,023	•	157,369
Non OECD % of Total	36.7	13.2	64.2	56.3	19.1	•	48.4

Non-OECD Trading Partners of OECD Members

TABLE I-2. MAJOR WORLD TRADE ROUTES - EXPORTS - 1974

ALL COMMODITIES

$ Million

Reporting Countries	U.S.	Canada	OECD Europe	Japan	Australia & New Zealand		OECD Total
					Aust	N.Z.	
Trade With							
U.S.	-	21,800	22,709	12,944	937	•	58,389
Canada	19,543	-	3,629	1,590	325	•	25,088
OECD Europe	27,099	4,865	-	8,559	1,729	•	42,252
Middle East	4,166	241	11,080	3,248	280	•	19,014
Africa	2,404	326	16,645	3,894	272	•	23,541
Japan	10,504	2,274	4,227	-	3,030	•	20,036
L/Dev Far East	8,713	630	8,114	12,688	1,601	•	31,748
Australia	2,159	314	3,420	2,077	-	•	7,969
New Zealand	450	66	972	488	718	•	2,694
Latin America	14,307	1,306	11,194	4,700	178	•	31,686
Total	89,345	31,822	81,990	50,188	9,070	•	262,417
World	97,143	32,780	113,603	55,598	10,787	•	309,911
Total % of World	92.0	97.1	72.2	90.3	84.1	•	84.7
Non OECD Total	29,590	2,503	47,033	24,530	2,331	•	105,989
Non OECD % Total	33.1	7.9	57.4	48.9	25.7	•	40.4

TABLE I-3. TRADE ROUTES - 1974 ALL COMMODITIES

		Imports $ Million	Exports(1) $ Million	Total $ Million
U.S. -	Canada	22,282	21,751	44,033
	OECD Europe	23,488	30,268	53,756
	Middle East	4,655	4,166	8,821
	Africa	5,973	2,404	8,377
	Japan	12,455	12,686	25,141
	L/Dev Far East	10,264	8,713	18,977
	Australia	1,083	2,282	3,365
	New Zealand	348	450	798
	Latin America	13,678	14,307	27,985
Canada -	OECD Europe	3,832	5,464	9,296
	Middle East	1,306	241	1,547
	Africa	273	326	599
	Japan	1,459	2,663	4,122
	L/Dev Far East	720	630	1,350
	Australia	343	331	674
	New Zealand	78	66	144
	Latin America	1,870	1,306	3,176
OECD Europe -	Middle East	39,356	11,080	50,436
	Africa	25,241	16,645	41,886
	Japan	7,593	5,164	12,757
	L/Dev Far East	8,386	8,114	16,500
	Australia	2,463	3,646	6,109
	New Zealand	968	972	1,940
	Latin America	11,023	11,194	22,217
Japan -	Middle East	15,319	3,248	18,567
	Africa	2,149	3,894	6,043
	L/Dev Far East	12,466	12,688	25,154
	Australia	4,335	2,039	6,374
	New Zealand	401	488	889
	Latin America	2,657	4,700	7,357
Australia -	Middle East	812	280	1,092
	Africa	65	272	337
	L/Dev Far East	1,059	1,601	2,660
	New Zealand	259	718	977
	Latin America	87	178	265
New Zealand -	Middle East	-	-	-
	Africa	-	-	-
	L/Dev Far East	-	-	-
	Latin America	-	-	-

(1) Where the trading partner is also an OECD member nation, the quantity is the reported imports for that nation.

TABLE I-4. TRADE ROUTE RANKING - 1974

ALL COMMODITIES

		$ (Millions)	%	CUM %
1.	U.S. - OECD Europe	53,756	12.39	12.39
2.	OECD Europe - Middle East	50,436	11.63	24.02
3.	U.S. - Canada	44,033	10.15	34.17
4.	OECD Europe - Africa	41,886	9.66	43.83
5.	U.S. - Latin America	27,985	6.45	50.28
6.	Japan - L/Dev Far East	25,154	5.80	56.08
7.	U.S. - Japan	25,141	5.80	61.88
8.	OECD Europe - Latin America	22,217	5.12	67.00
9.	U.S. - L/Dev Far East	18,977	4.38	71.38
10.	Japan - Middle East	18,567	4.28	75.66
11.	OECD Europe - L/Dev Far East	16,500	3.80	79.46
12.	OECD Europe - Japan	12,757	2.94	82.40
13.	Canada - OECD Europe	9,296	2.14	84.54
14.	U.S. - Middle East	8,821	2.03	86.57
15.	U.S. - Africa	8,377	1.93	88.50
16.	Japan - Latin America	7,357	1.70	90.20
17.	Japan - Australia	6,374	1.47	91.67
18.	OECD Europe - Australia	6,109	1.41	93.08
19.	Japan - Africa	6,043	1.39	94.47
20.	Canada - Japan	4,122	0.95	95.42
21.	U.S. - Australia	3,365	0.78	96.20
22.	Canada - Latin America	3,176	0.73	96.93
23.	Australia - L/Dev Far East	2,660	0.61	97.54
24.	OECD - New Zealand	1,940	0.45	97.99
25.	Canada - Middle East	1,547	0.36	98.35
26.	Canada - L/Dev Far East	1,350	0.31	98.66
27.	Australia - Middle East	1,092	0.25	98.91
28.	Australia - New Zealand	977	0.23	99.14
29.	Japan - New Zealand	889	0.22	99.36
30.	U.S. - New Zealand	798	0.18	99.54
31.	Canada - Australia	674	0.16	99.70
32.	Canada - Africa	599	0.14	99.84
33.	Australia - Africa	337	0.08	99.92
34.	Australia - Latin America	265	0.06	99.98
35.	Canada - New Zealand	144	0.03	100.01
	Total	433,721	100.00	
	Total OECD - Non-OECD	263,346	60.7	

NOTE: 20 out of 35 with non-OECD partners

24.5% of Total trade value is Commodity Group 3 - Mineral Fuels, Lubricants and Related Materials

TABLE I-5. MAJOR WORLD TRADE ROUTES - IMPORTS - 1974
COMMODITY GROUP 3 ONLY
$ MILLION

Reporting Countries Trade With	U.S.	Canada	OECD Europe	Japan	Australia & New Zealand Aust.	 N.Z.	OECD Total
U.S.	-	452	1,052	1,833	17	•	3,354
Canada	4,534	-	131	334	-	•	4,999
OECD Europe	1,301	24	-	74	7	•	1,406
Middle East	4,216	1,277	37,819	15,085	779	•	59,176
Africa	4,743	89	14,654	887	1	•	20,374
Japan	13	-	11	-	4	•	28
L/Dev Far East	1,405	-	41	4,985	114	•	6,545
Australia	6	1	168	860	-	•	1,035
New Zealand	1	-	-	1	-	•	2
Latin America	4,814	1,346	1,038	58	3	•	7,259
Total	21,033	3,189	54,914	24,117	925	•	104,178
World	25,350	3,391	59,908	24,897	933	•	114,479
Total % of World	83.0	94.0	91.7	96.9	99.1	•	91.0
Non-OECD Total	15,178	2,712	53,552	21,015	897	•	93,354
% of Total	72.2	85.0	97.5	87.1	97.0	•	89.6

TABLE I-6. MAJOR WORLD TRADE ROUTES - EXPORTS - 1974
COMMODITY GROUP 3 ONLY
$ MILLIONS

Reporting Countries	U.S.	Canada	OECD Europe	Japan	Australia & New Zealand		OECD Total
Trade With					Aust.	N.Z.	
U.S.	-	4,785	740	3	5	•	5,534
Canada	531	-	15	-	-	•	545
OECD Europe	884	121	-	54	103	•	1,162
Middle East	29	-	177	1	3	•	210
Africa	20	-	525	1	2	•	548
Japan	1,447	257	57	-	674	•	2,435
L/Dev Far East	65	1	39	156	43	•	305
Australia	26	-	11	4	-	•	41
New Zealand	7	-	4	2	74	•	86
Latin America	378	5	91	26	3	•	502
Total	3,387	5,169	1,659	247	907		11,368
World	3,442	5,179	3,528	251	947	•	13,347
Total % of World	98.4	99.8	47.0 (1)	98.4	95.8	•	85.2
Non-OECD Total	492	6	832	184	51	•	1,565
% of Total	14.5	0.12	50.2	74.4	5.6	•	13.8

(1) In addition to $1,659 million, there is $1,504 million with "Unspecified" trading partner, hence the unusually low percentage of 47.0.

TABLE I-7. TRADE ROUTES - 1974
COMMODITY GROUP 3 ONLY

		Imports $ Million	Exports[1] $ Million	Total $ Million
U.S.	- Canada	4,534	452	4,986
	OECD Europe	1,301	1,052	2,353
	Middle East	4,216	29	4,245
	Africa	4,743	20	4,763
	Japan	13	1,833	1,846
	L/Dev Far East	1,405	65	1,470
	Australia	6	17	23
	New Zealand	1	7	8
	Latin America	4,814	378	5,192
Canada	- OECD Europe	24	131	155
	Middle East	1,277	-	1,277
	Africa	89	-	89
	Japan	-	334	334
	L/Dev Far East	-	1	1
	Australia	1	-	1
	New Zealand	-	-	-
	Latin America	1,346	5	1,351
OECD Europe	- Middle East	37,819	177	37,996
	Africa	14,654	525	15,179
	Japan	11	74	85
	L/Dev Far East	41	39	80
	Australia	168	7	175
	New Zealand	-	4	4
	Latin America	1,038	91	1,129
Japan	- Middle East	15,085	1	15,086
	Africa	887	1	888
	L/Dev Far East	4,985	156	5,141
	Australia	860	4	864
	New Zealand	1	2	3
	Latin America	58	26	84
Australia	- Middle East	779	3	782
	Africa	1	2	3
	L/Dev Far East	114	43	157
	New Zealand	-	74	74
	Latin America	3	3	6

(1) Where the trading partner is also an OECD member country, the quantity is the reported imports for that country.

TABLE I-8. TRADE ROUTE RANKING - 1974

COMMODITY GROUP 3 ONLY

		$ (Millions)	%	CUM %
1.	OECD Europe - Middle East	37,996	35.90	35.90
2.	OECD Europe - Africa	15,179	14.34	50.24
3.	Japan - Middle East	15,086	14.25	64.49
4.	U.S. - Latin America	5,192	4.91	69.40
5.	Japan - L/Dev Far East	5,141	4.86	74.26
6.	U.S. - Canada	4,986	4.71	78.97
7.	U.S. - Africa	4,763	4.50	83.47
8.	U.S. - Middle East	4,245	4.01	87.48
9.	U.S. - OECD Europe	2,353	2.22	89.70
10.	U.S. - Japan	1,846	1.74	91.44
11.	U.S. - L/Dev Far East	1,470	1.39	92.83
12.	Canada - Latin America	1,351	1.28	94.11
13.	Canada - Middle East	1,277	1.21	95.32
14.	OECD Europe - Latin America	1,129	1.07	96.39
15.	Japan - Africa	888	0.839	97.229
16.	Japan - Australia	864	0.816	98.045
17.	Australia - Middle East	782	0.739	98.784
18.	Canada - Japan	334	0.316	99.100
19.	OECD Europe - Australia	175	0.165	99.265
20.	Australia - L/Dev Far East	157	0.148	99.413
21.	Canada - OECD Europe	155	0.146	99.559
22.	Canada - Africa	89	0.084	99.643
23.	OECD Europe - Japan	85	0.080	99.723
24.	Japan - Latin America	84	0.079	99.802
25.	OECD Europe - L/Dev Far East	80	0.076	99.878
26.	Australia - New Zealand	74	0.070	99.948
27.	U.S. - Australia	23	0.022	99.970
28.	U.S. - New Zealand	8	0.008	99.978
29.	Australia - Latin America	6	0.006	99.984
30.	OECD Europe - New Zealand	4	0.004	99.988
31.	Japan - New Zealand	3	0.003	99.991
32.	Australia - Africa	3	0.003	99.994
33.	Canada - L/Dev Far East	1	0.001	99.995
34.	Canada - Australia	1	0.001	99.996
35.	Canada - New Zealand	-	-	
	Total	105,830	100.00	
	Total OECD - Non-OECD	94,919	89.69	

TABLE I-9. MAJOR WORLD TRADE ROUTES - IMPORTS - 1974
WITHOUT COMMODITY GROUP 3
$ MILLION

Reporting Countries	U.S.	Canada	OECD Europe	Japan	Australia & New Zealand		OECD Total
Trade With					Aust.	N.Z.	
U.S.	-	21,299	29,216	10,853	2,265	•	63,633
Canada	17,748	-	5,333	2,329	331	•	25,741
OECD Europe	22,187	3,808	-	5,090	3,639	•	34,724
Middle East	449	29	1,537	234	33	•	2,282
Africa	1,230	184	10,587	1,262	64	•	13,327
Japan	12,442	1,459	7,582	-	2,035	•	23,518
L/Dev Far East	8,859	720	8,345	7,481	945	•	26,350
Australia	1,077	342	2,295	3,475	-	•	7,189
New Zealand	347	78	968	400	259	•	2,052
Latin America	8,864	524	9,985	2,599	84	•	22,056
Total	73,203	28,443	75,848	33,723	9,588	•	220,805
World	75,622	28,904	94,524	37,138	10,154	•	246,342
Total % of World	96.8	98.4	80.2	90.8	94.4	•	89.6
Non OECD Total	19,402	1,457	30,454	11,576	1,126	•	64,015
% of Total	26.5	5.1	40.2	34.3	11.7	•	29.0

TABLE I-10. MAJOR WORLD TRADE ROUTES - EXPORTS - 1974
WITHOUT COMMODITY GROUP 3
$ MILLION

Reporting Country	U.S.	Canada	OECD Europe	Japan	Australia & New Zealand		OECD Total
Trade With					Aust.	N.Z.	
U.S.	-	17,015	21,969	12,941	932	•	52,855
Canada	19,012	-	3,614	1,590	325	•	24,543
OECD Europe	26,215	4,744	-	8,505	1,626	•	41,090
Middle East	4,137	241	10,903	3,247	277	•	18,804
Africa	2,384	326	16,120	3,893	270	•	22,993
Japan	9,057	2,017	4,170	-	2,356	•	17,601
L/Dev Far East	8,648	629	8,075	12,532	1,558	•	31,443
Australia	2,133	314	3,409	2,073	-	•	7,928
New Zealand	443	66	968	486	644	•	2,608
Latin America	13,929	1,301	11,103	4,674	175	•	31,184
Total	85,958	26,653	80,331	49,941	8,163	•	251,049
World	93,701	27,601	110,075	55,347	9,840	•	296,564
Total % of World	91.7	96.6	73.0	90.2	83.0	•	84.7
Non-OECD Total	29,098	2,497	46,201	24,346	2,280	•	104,424
% of Total	33.9	9.4	57.5	48.7	27.9	•	41.6

TABLE I-11. TRADE ROUTES - 1974
WITHOUT COMMODITY GROUP 3

		Imports $ Million	Exports(1) $ Million	Total $ Million
U.S.	- Canada	17,748	21,299	39,047
	OECD Europe	22,187	29,216	51,403
	Middle East	439	4,137	4,576
	Africa	1,230	2,384	3,614
	Japan	12,442	10,853	23,295
	L/Dev Far East	8,859	8,648	17,507
	Australia	1,077	2,265	3,342
	New Zealand	347	443	790
	Latin America	8,864	13,929	22,793
Canada	- OECD Europe	3,808	5,333	9,141
	Middle East	29	241	270
	Africa	184	326	510
	Japan	1,459	2,329	3,788
	L/Dev Far East	720	629	1,349
	Australia	342	331	673
	New Zealand	78	66	144
	Latin America	524	1,301	1,825
OECD Europe	- Middle East	1,537	10,903	12,440
	Africa	10,587	16,120	26,707
	Japan	7,582	5,090	12,672
	L/Dev Far East	8,345	8,075	16,420
	Australia	2,295	3,639	5,934
	New Zealand	968	968	1,936
	Latin America	9,985	11,103	21,088
Japan	- Middle East	234	3,247	3,481
	Africa	1,262	3,893	5,155
	L/Dev Far East	7,481	12,532	20,013
	Australia	3,475	2,035	5,510
	New Zealand	400	486	886
	Latin America	2,599	4,674	7,273
Australia	- Middle East	33	277	310
	Africa	64	270	334
	L/Dev Far East	945	1,558	2,503
	New Zealand	259	644	903
	Latin America	84	175	259

(1) Where the trading partner is also an OECD member country, the quantity is the reported imports for that country.

TABLE I-12. TRADE ROUTE RANKING - 1974
WITHOUT COMMODITY GROUP 3

			$ (Millions)	%	CUM %
1.	U.S.	- OECD Europe	51,403	15.68	15.68
2.	U.S.	- Canada	39,047	11.91	27.59
3.	OECD Europe	- Africa	26,707	8.15	35.74
4.	U.S.	- Japan	23,295	7.10	42.84
5.	U.S.	- Latin America	22,793	6.95	49.79
6.	OECD Europe	- Latin America	21,088	6.43	56.22
7.	Japan	- L/Dev Far East	20,013	6.10	62.32
8.	U.S.	- L/Dev Far East	17,507	5.34	67.66
9.	OECD Europe	- L/Dev Far East	16,420	5.01	72.67
10.	OECD Europe	- Japan	12,672	3.86	76.53
11.	OECD Europe	- Middle East	12,440	3.79	80.32
12.	Canada	- OECD Europe	9,141	2.79	83.11
13.	Japan	- Latin America	7,273	2.22	85.33
14.	OECD Europe	- Australia	5,934	1.81	87.14
15.	Japan	- Australia	5,510	1.68	88.82
16.	Japan	- Africa	5,155	1.57	90.39
17.	U.S.	- Middle East	4,576	1.40	91.79
18.	Canada	- Japan	3,788	1.16	92.95
19.	U.S.	- Africa	3,614	1.10	94.05
20.	Japan	- Middle East	3,481	1.06	95.11
21.	U.S.	- Australia	3,342	1.02	96.13
22.	Australia	- L/Dev Far East	2,503	0.763	96.893
23.	OECD Europe	- New Zealand	1,936	0.590	97.483
24.	Canada	- Latin America	1,825	0.557	98.04
25.	Canada	- L/Dev Far East	1,349	0.411	98.451
26.	Australia	- New Zealand	903	0.275	98.726
27.	Japan	- New Zealand	886	0.270	98.996
28.	U.S.	- New Zealand	790	0.241	99.237
29.	Canada	- Australia	673	0.205	99.442
30.	Canada	- Africa	510	0.156	99.598
31.	Australia	- Africa	334	0.102	99.700
32.	Australia	- Middle East	310	0.095	99.795
33.	Canada	- Middle East	270	0.082	99.877
34.	Australia	- Latin America	259	0.079	99.956
35.	Canada	- New Zealand	144	0.044	100.00
		Total	327,891	100.00	
		Total OECD - Non OECD	168,427	51.4	

TABLE I-13. OECD REPORTING MEMBERS - SUMMARY IMPORTS AND EXPORTS

	All Commodities $ (Millions)	Commodity Group 3 $ (Millions)	Without Commodity Group 3 $ (Millions)
1. With all trading partners			
U.S.	191,253	24,886	166,367
Canada	20,908	3,208	17,700
OECD Europe	151,845	54,648	97,197
Japan	64,384	22,066	42,318
Australia	5,331	1,022	4,309
Total	433,721	105,830	327,891
2. With non-OECD trading partners			
U.S.	64,160	15,670	48,490
Canada	6,672	2,718	3,954
OECD Europe	131,039	54,384	76,655
Japan	57,121	21,199	35,922
Australia	4,354	948	3,406
Total	263,346	94,919	168,427
% with non-OECD trading partners	60.7	89.7	51.4

the results for non-OECD trading partners, and here the predominance is European.

The basic OECD data for each reporting country is represented in numerical order of the SITC codes. In order to establish the air penetrable commodities, the OECD data output was regrouped based on the degrees of containerization developed from the MarAd analyses. The degree of containerization by commodity is detailed in Table I-14 of this appendix supplement, and representing imports and exports combined.

The original degrees of containerization as developed by MarAd for imports and exports separately are presented in Supplement A. Since the OECD data includes trade between two foreign countries the levels of containerization for U.S. imports and U.S. exports could not be applied. It was decided that an approximation representing the combination of U.S. imports and exports giving a single value of percent containerization per commodity would be appropriate. From the basic MarAd analysis it is seen that many commodities exhibit the same level of containerization for both imports and exports and thus a single value is already available. Where differences exist in the rate of containerization for imports versus exports then generally the higher rate was chosen, representing a higher degree of maturity of containerization. Where the directional imbalance in U.S. trade flow is large, the rate of containerization of the higher trade flow was chosen.

OECD Foreign Trade Data

The major source of data for the Free-World international cargo demand is the OECD foreign trade data. Data Resources Inc. of Washington, D.C. has the OECD foreign trade data known as Series C, in a computerized system. They were contracted to extract data based on the country pair combinations and commodity groupings outlined in the previous paragraphs. The basic Series C data are reported by commodity at the 4-digit level for 1961 through 1969 and the 5-digit level for 1970 through 1975. To reduce the final output to a workable level these were required to be aggregated to the 3-digit level. Further, the commodities were regrouped by degrees of containerization based on information developed from MarAd analyses.

Each of the OECD member countries reports data to the OECD on both value and quality of exports to and imports from approximately 160 partner countries. Depending on the commodity, up to 23 of these partner countries are other OECD member countries, the remainder being non-member countries from Argentina to Zaire. The value data are standardized by using an appropriate exchange rate for each year and converting the value of each member country's imports and exports into U.S. dollars. Tasks of aggregation and comparison for value data are thus greatly simplified. Given the diversity of data collection techniques and reporting methods in the OECD member countries, the method for dealing with quantity aggregations is much more difficult.

TABLE I-14-1. RATE OF CONTAINERIZATION -- 3-DIGIT CENSUS SCHEDULE A & B

IMPORTS AND EXPORTS

		Percent Containerized					
Code	Commodity Description	Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
001	Live Animals			X			
011	Meat, Fresh, Chilled or Frozen					X	
012	Meat, Dried, Slted, or Smoked				X		
013	Meat in Cont, N.E.S.					X	
022	Milk and Cream					X	
023	Butter and Anhydrous Milk Fat						X
024	Cheese and Curd						X
025	Eggs, Birds, Excl. Egg Album						X
031	Fish, Fresh, or Simply Preserved				X		
032	Fish, Airtight Cont, N.E.C.					X	
041	Wheat, Unmilled	X					
042	Rice		X				
043	Barley, Unmilled	X					
044	Corn or Maize, Unmilled	X					
045	Cereals, Unmilled, N.E.S.	X					
046	Wheat Flour, Meal, and Groats		X				
047	Cereal Flour, Meal and Groats		X				
048	Cereal and Flour Preparations			X			
051	Fruits, Fresh			X			
052	Fruits, Dried					X	
053	Nuts & Fruits, N.E.S.					X	
054	Vegetables, Fresh, Chld, Frzn.					X	
055	Vegetables, Preserved N.E.S.					X	
061	Sugar, Syrups, Molasses, Honey	X					
062	Sugar, Confectionery						X
071	Coffee		X				
072	Cocoa			X			
073	Chocolate						X
074	Tea and Mate				X		
075	Spices				X		
081	Feeding-Stuff for Animals		X				
091	Margarine and Edible Fats			X			
099	Food Preparations, N.E.C.				X		
111	Nonalcoholic Beverages, N.E.C.					X	
112	Alcoholic Beverages						X
121	Tobacco, Unmanufactured					X	
122	Tobacco Manufactures				X		

TABLE I-14-2. RATE OF CONTAINERIZATION -- 3-DIGIT CENSUS SCHEDULE A & B

IMPORTS AND EXPORTS

Code	Commodity Description	Percent Containerized Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
211	Hides & Skins, Undressed					X	
212	Fur Skins, Undressed						X
221	Oil Seeds, Oil Nuts, Kernels		X				
231	Rubber Crude			X			
241	Fuel Wood, Charcoal, and Waste		X				
242	Wood, In the Rough		X				
243	Wood, Shaped or Simply Worked		X				
244	Cork, Natural, Raw and Waste			X			
251	Pulps and Waste Paper				X		
261	Silk, Raw					X	
262	Wool and Other Animal Hair						X
263	Cotton				X		
264	Jute			X			
265	Fibers, Vegetable N.E.S.			X			
266	Man Made Fibers						X
267	Waste from Textile Fabrics					X	
271	Fertilizers, Crude	X					
273	Stone, Sand, and Gravel	X					
274	Sulphur and Crude Iron Pyrites	X					
275	Natural Abrasives, Inc. Diamond				X		
276	Crude Minerals N.E.S.		X				
281	Iron Ore and Concentrates	X					
282	Iron and Steel Scrap		X				
283	Ores, Concentrates Nonferrous	X					
284	Nonferrous Metal Scrap					X	
285	Platinum		X				
286	Uranium, Thorium Ores and Cons.		X				
291	Animal Materials, NES, Crude				X		
292	Vegetable Materials NES, Crude			X			
321	Coal, Coke and Briquets	X					
331	Petroleum, Crude	X					
332	Petroleum, Products	X					
341	Gas, Natural & Manufactured	X					
411	Animal Oils and Fats N.E.S.		X				
421	Fixed Vegetable Oils, Soft		X				
422	Fixed Vegetable Oils, N.E.C.		X				
431	Fatty Acids, Waxes, Fats, Oils				X		

TABLE I-14-3. RATE OF CONTAINERIZATION -- 3-DIGIT CENSUS SCHEDULE A & B

IMPORTS AND EXPORTS		Percent Containerized					
Code	Commodity Description	Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
512	Organic Chemicals			X			
513	Inorganic Chemical Elements		X				
514	Inorganic Chem. Except Elements			X			
515	Radioactive & Stable Isotopes						X
521	Mineral Tar and Tar Oils	X					
531	Synthetic Organic Dyestuffs						X
532	Dyeing and Tanning Extracts			X			
533	Pigments, Paints, Varnish				X		
541	Medic and Pharmac. Products						X
551	Essential Oils, Perfume				X		
553	Perfumes, Cosmetics, Dentrifrices					X	
554	Soaps and Polishing Preps				X		
561	Fertilizers, Manufactured		X				
571	Explosives & Pyrotechnic Pro.				X		
581	Plastic Materials, Syn. Resins					X	
599	Chem. Prods and Materials, N.E.C.			X			
611	Leather					X	
612	Manufactures of Leather N.E.C.						X
613	Fur Skins, Dressed						X
621	Rubber Manufactures, Unvulcaniz				X		
629	Rubber, Mfgrs. Finished NEC						X
631	Wood Veneers, Plywood Boards		X				
632	Wood Manufactures, N.E.C.						X
633	Cork Manufactures			X			
641	Paper and Paperboard			X			
642	Articles & Paper Pulp, Paper				X		
651	Textile Yarn and Thread						X
652	Cotton Fabrics, Woven						X
653	Textile Fabrics, Woven				X		
654	Tulle, Lace, Embroidery, Etc.				X		
655	Special Textile Fabrics, Incl				X		
656	Made-Up Articles, Textile, NEC						X
657	Floor Covering, Tapestries, Etc.						X
661	Building Material, Lime, Cement		X				
662	Clay and Ref. Constru Material					X	
663	Mineral Manufactures, N.E.C.					X	
664	Glass					X	

TABLE I-14-4. RATE OF CONTAINERIZATION -- 3-DIGIT CENSUS SCHEDULE A&B

IMPORTS AND EXPORTS

		Percent Containerized					
Code	Commodity Description	Liquid & Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
665	Glassware						X
666	Pottery						X
667	Precious, Semi-Precious Stones			X			
671	Pig Iron		X				
672	Iron or Steel Primary Forms		X				
673	Iron or Steel Bars		X				
674	Iron or Steel Plates & Sheets			X			
675	Hoop & Strip of Iron or Steel			X			
676	Rails or Railway Track Materia		X				
677	Iron or Steel Wire, Excl.				X		
678	Iron or Steel Tubes, Fittings		X				
679	Iron or Steel Castings, Forging				X		
681	Silver and Platinum				X		
682	Copper & Copper Alloy				X		
683	Nickel & Nickel Alloys Etc.					X	
684	Aluminum & Aluminum Alloys					X	
685	Lead & Lead Alloys				X		
686	Zinc & Zinc Alloys			X			
687	Tin & Tin Alloys				X		
688	Uranium & Thorium Metal		X				
689	Non Ferrous Base Metal N.E.C.				X		
691	Fin. Structural Metal Parts NE			X			
692	Metal Containers for Storage				X		
693	Wire Pro. Non Electric Fencing				X		
694	Nails, Screw, Nuts, Bolts, Etc.				X		
695	Hand and Machine Tools				X		
696	Table Flatware and Cutlery						X
697	Household Equip. of Base Metal						X
698	Manufactures of Metal, N.E.C.					X	
711	Power Generating Machinery						X
712	Agricultural Machinery, Etc.				X		
714	Office Machines and Parts						X
715	Metalworking Machinery & Parts					X	
717	Textile & Leather Machinery						X
718	Mach. for Spec Industr.				X		
719	Mach & Appliance N.E.C.					X	
722	Electric Power Machinery					X	

TABLE I-14-4. RATE OF CONTAINERIZATION -- 3-DIGIT CENSUS SCHEDULE A & B

IMPORTS & EXPORTS

Code	Commodity Description	Percent Containerized Liquid or Dry Bulk	0-5%	5-20%	20-40%	40-60%	60-100%
723	Equip. for Distributing Elec.					X	
724	Telecommunications Apparatus						X
725	Electric Refrigerators						X
726	Electric Apparatus, Medical						X
729	Electrical Machinery N.E.S.					X	
731	Railway Vehicles and Parts				X		
732	Road Motor Vehicles and Parts			X			
733	Vehicles Other Than Road Mtr						X
734	Aircraft and Spacecraft				X		
735	Ships, Boats, Floating Struct.				X		
812	Plumb. Heating, Equip Lightfix					X	
821	Furniture						X
831	Travel Goods, Handbags, Etc.						X
841	Clothing, Etc. Not Fur						X
842	Fur Clothing Incl.						X
851	Footwear						X
861	Scientific, Med. Apparat. N.E.C.					X	
862	Photographic Supplies, Incl.						X
863	Motionpicture, Photofilm N.E.C.						X
864	Watches & Clocks Parts Incl.						X
891	Sound Recorders and Parts						X
892	Printed Matter						X
893	Plastic Manufactures, N.E.C.						X
894	Baby Carriages, Toys, Games						X
895	Office & Stationery Supplies						X
896	Works of Art, Antiques						X
897	Jewelry and Related Articles					X	
899	Manufactured Articles, N.E.C.						X
931	Spec. Transactions not Class				X		
941	Animals. Live. N.E.C. Incl					X	
951	Armored Fighting Vehicles, Arms						X
952	Military Apparel and Footwear						X
961	Coin, Other than Gold		X				
999	All Other Commodities			X			

Although by far the majority of quantities reported are in metric tons, significant exceptions exist. From our experience with the Trade Series C data, it appears that if a member country does not report metric volumes, no conversions are made by the OECD and quantity data for these reporters are not available on the tapes. Thus, inconsistencies exit across OECD reporting countries. A second, and only slightly less troubling, problem stems from the fact that the OECD Trade Series C data base is cross-sectional in conception. In other words, each year a cross-sectional report is published describing trade for that year between the OECD members and their partners. Occasionally, since 1961 when publication began, some reporting countries changed the unit of measures in which they reported import and/or export volumes for specific commodities. This creates considerable difficulties in attempting to deal with the data in the time series format required for making extrapolations.

Recognizing all of these problems and the fact that the OECD Trade Series C data base is still the best single source of foreign trade data available with which to examine commodity trade between countries, a methodology was devised by which the available data could be used to approximate the unavailable quantity data. Since the European OECD reporting countries had excellent quantity data available, it was decided that proxy trade volumes could be developed for those reporters for which trade volume were unavailable. The method used was to divide the average unit value of the commodity in OECD Europe into the value of trade in that commodity in the country for which no quantity data were available. Thus, proxy trade volumes in metric tons were derived.

Wherever possible, a similar method was used to obtain proxies to fill gaps within a time series when the unit of measure had changed from year to year. The decision rule used in applying proxies was determined by the percentage of actual data reported in metric tons for a given set of partners. DRI found the actual volumes in the inconsistencies to be small, so that if 90 percent or more of the number of series in the aggregate were reported in metric tons, the actual data were used. Visual inspection of these series was necessary, however, to assure consistency. For a few commodities, this methodology proved to be unworkable where unit values varied greatly across countries or where the reporting units in OECD Europe were not metric tons. In such cases, there was no alternative but to exclude the commodity as not having been reported in tons.

Once all of these tests had been made, the task of extrapolating the series was approached. After examining the problem closely, it was decided jointly between DRI and Lockheed-Georgia to use a linear technique. This decision was required because the final time series extrapolations amounted to 6000 representing the 3-digit level aggregations for the 25 country pairs, imports and exports. However, it must be recognized that approximately three million time series were used in arriving at the aggregations.

Since the solution using the linear technique required non-zero data within each series, zero elements within the series were replaced by the means of adjacent period volumes (e.g., missing data for 1968 were replaced by the mean of the observations for 1967 and 1969) and leading and trailing observations containing zeros were truncated. Finally, a linear regression was performed on each resulting series to derive the extrapolated or forecasted values. The extrapolation or forecast being based on the best linear fit through the historical time series points, and thus the forecast of the tonnage for each commodity does not commence from the historical data point for 1975. Since the forecast data were developed for 5-year increments from 1975, the growth for the final historical point to 1980 does not appear to be compatible with the growth between 1980 and the year 2000.

The final output from the OECD foreign trade data Series C, the forecast at the 3-digit level commodity aggregation by degree of containerization, provided good results for the 0 to 5 percent through the 60 to 100 percent containerization. Due to problems with the units of quantity, the output provided unacceptable results for the 15 liquid and dry bulk commodities. Since these would have been eliminated anyway, the loss does not detract from the overall value of the results. Thus, the analysis of the OECD data represents only containerizable and containerized commodities. The DRI results for imports and exports are bound separately and may be obtained from NASA, Langley.

The output of the OECD data analyses in arriving at the AACS demand are presented for Free-World International Cargo Demand - Table II; U.S. International Cargo Demand - Table III; OECD Europe International Cargo Demand - Table VI; Japan International Cargo Demand - Table V; and MACRO Regional Grouping Cargo Demand - Table VI. Each of these tables is further subdivided in an identical manner as outlined as follows. For ease of reference, the first group - Free-World International Cargo Demand - Table II will be used as the guide.

The OECD data are not available for the separate modes, but since the country/region pairs analyzed mostly represent intercontinental trade, the data represent just two modes: air and sea. These totals are presented in Tables II-1 through II-3 for imports, exports, and imports and exports. The data are provided for each country/region pair and each degree of containerization for 1973, 1974, and 1975, and five-year increments are forecast to the year 2000. Tables II-4 through II-6 summarize these data giving just the totals for each country/region pair, representing degrees of containerization of 0 to 100 percent.

Air penetration derived from analyses of the Department of Commerce U.S. foreign trade data by modes is applied to the OECD data to separate out the conventional air cargo. This estimated air cargo is presented in the same formats as the OECD total trade data in Tables II-7 through II-12.

This air cargo is then subtracted from the OECD total trade to give the OECD total seaborne cargo. This total seaborne actually represents the containerizable trade since the 15 dry and liquid bulk commodities have been eliminated from these analyses. These containerizable seaborne tonnages are presented in Tables II-13 through II-18.

Multiplying the containerizable tonnages for each degree of containerization by the mean of the range produces the containerized tonnage. These results are presented in Tables II-19 through II-24.

The remaining tables, Tables II-25 through II-33 are for only the summary level by country/region-pair. Tables II-25 through II-27 present containerized tonnage express as a percent of the containerizable tonnage. The percentages range from a low of 6 to a high of 56. These percentages, of course, exclude the affect of the 15 dry and liquid bulk commodities; otherwise, the percentages would have had a high in the order of 3 to 4 percent.

The demand for the Advanced Air Cargo System, Tables II-28 through II-30 is obtained by taking 5.6 percent of the seaborne containerized tonnage as established from the case study results of Section II of the main body of the report. This represents the low forecast for the AACS.

Finally, Tables II-31 through II-33 present the addition of the conventional air cargo demand and the AACS demand to give the Free-World total air cargo demand.

As mentioned before, this structure of these tables, Table II-1 through II-33, is used throughout Table II through Table VI. It is from the last one, Table VI for the MACRO Regional Grouping Cargo Demand, that data are taken as inputs to the MACRO optimization program to arrive at the demand for aircraft.